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Visibility in the automotive supply chain: improving the vehicle delivery process at FCA

Relatore

Prof.ssa Anna Cagliano

Correlatore

Ing. Roberto Braida (FCA)

Candidato

Alessandro Ferrari

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Abstract

The aim of this work is to analyze the status of visibility and tracking of goods in the supply chain environment, with particular attention to the outbound side of automotive industry, thanks to an internship conducted in the Supply Chain Management division of Fiat Chrysler Automobiles, in Turin's Headquarter, between October and December 2018, and consequent master thesis at this company until March 2019. This topic is not investigated by current literature, that examines in depth automotive visibility on the inbound side and in plant, but is becoming more and more important, mainly due to an increasing request of customers to be involved in the information sharing with the automotive manufacturers, and due to an efficiency improvement that a supply chain with good visibility might generate.

During the course of the internship, FCA developed a project called Delivery Process Improvement, to analyze complaints regarding delays in the delivery of vehicles to final customers, and to solve problems related to their expectations. These issues are linked to the topics of the work, because customers are strongly requesting the possibility of tracking their products to know in which stage they are currently, and this requires an improvement of visibility from the company and a stronger communication between parts (mainly FCA and dealers).

The first part of this work examines the definition of visibility, how it can be measured and why paying close attention to it could be valuable for companies. An example has been introduced regarding Amazon, why it is the best-in-class company in this field currently, and how other organizations should take it as a standard to imitate. After that, an analysis of the tracking technologies used nowadays in logistics environment and in particular in the automotive industry has been performed. Moreover, a literature review has been drawn to detect a research gap that this work would try to fill.

Later on, the company FCA has been introduced with a brief description for all the brands that compose it, and the division in which the work has been developed, with a view of Supply Chain Management, and Process & Methods subdivision in particular.

The third section includes a description of the Order to Delivery process, to highlight where problems regarding visibility could be found. It is also outlined how the distribution process for FCA occurs, what are the main stages and actors involved in these operations. Fundamental for the successive part is the description of how and when an order is submitted and how priorities are set for FCA.

Thereafter, the tools that FCA and the dealers use to achieve visibility have been introduced, in particular software and indexes. Then, the Delivery Process Improvement project is presented, starting from how a sample of complaint vehicles (for a delay in the delivery to final customer) has been extracted, how these cars have been divided in categories (sales method and then perceived problems) and numerical results to highlight which could be the main issues to focus on. The main criticalities that have been pointed out from the analysis concerned the proper setting of customer expectation by the dealer, regarding the forecast of vehicle delivery. Indeed, the communication between FCA and the dealer has weak points that do not allow him to give to the customer a strong Promised Delivery Date, that most of the times is not even transmitted to FCA. The solutions proposed try to fix these issues, changing the current ICT infrastructure to give the dealer the best tools and information to formulate a proper forecast delivery.

Finally, after the solutions that Delivery Process Improvement project has detected to be useful, it has been listed what could be the expected benefits by FCA, mainly an increase in customer expectation that will decrease the number of complaints, then which were the limitations of this work and a proposal of next steps for the company.

Chapter 1 - Introduction to Visibility and Tracking in the Supply Chain

The first chapter's intention is to give a global overview of the concept of visibility and tracking in the supply chain, giving appropriate definitions, analyzing what are the main effects and examining in depth technologies used nowadays, with a focus on automotive industry.

1.1 Definition of Visibility – Overall Visibility Index

A crucial element for modern supply chain is visibility. Before starting an analysis of this concept, it is necessary to give some definitions to clarify the environment which this work is contextualized in. First of all, the term Supply Chain can be defined as "a network of organizational entities that are connected and interdependent. These coordinately operate to manage, to check, and to improve material and informational flows, that originate from the suppliers and have an ending when they reach the final customers, after going through subsystems of procurement, production and distribution of a firm." (Dallari and Marchet, 2003). From here the concept of Supply Chain Management (SCM) develops, and as the Council of Supply Chain Management Professionals states: "SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies." [1].

Then, the definition of visibility can be addressed. It is not unique, although it is a well-known concept studied by many authors. The available definitions are given emphasizing different aspects, for example information exchange: "Visibility is the ability to access/share information across the supply chain and to use it in real time." (Lamming et al., 2001), or with a specific focus on the relationship with business partners: "Supply chain visibility does not mean sharing all information with all partners in the supply chain, but rather that the shared information should be relevant and meaningful. End-to-end visibility can be defined as the sharing of all relevant information between supply chain partners, also over echelons in the chain" (Kaipia and Hartiala, 2006).

Furthermore, visibility has a range of levels determined by the amount of useful information that is shared across the supply chain. A transition is occurring from supply chain to supply network, due to a high level of externalization and an enlargement of the distances covered, making visibility harder to study.

This topic cannot be applied in some industries, where nowadays reducing lead times because of the necessity of a faster response to consumer's demand has become more important than having low manufacturing costs in production plant in Asia. This phenomenon that is taking place is called *nearshoring*, and it affects first of all fast fashion industry, with companies like Zara or H&M that are moving production plants closer to Europe. The extremization of this concept of nearshoring is called *reshoring*, when production plants are brought back in the country of origin.

Visibility can bring improvements at more levels:

- Operational: preventing the effect of stock-outs, which would stop or slow down the production process, and increasing resource productivity;
- Tactical: reducing inventories and safety lead-times associated.

A study of 2010 (Caridi et al., 2010) tries a quantitative approach to assess supply chain visibility. The authors applied the following model on six companies from different industries. To provide an Overall Visibility Index, four types of information flows are considered (Bracchi et al., 2001):

- Transaction/Events: information that has to be communicated when an event takes place;
- Status Information: information that describes the status of some resources or of a process;
- Master Data: information linked to the features of products;
- Operational Plans: information about the company's future plans.

In addition to quantity of information exchanged, two dimensions of quality are considered: freshness, as the degree of information "synchronization" with business partners, and accuracy, as the degree of conformity of the shared information with its actual value. Therefore, three scales on four response levels have been proposed: one to measure quantity and two to measure quality, in the form of freshness and accuracy. A discrimination must be made regarding freshness: different information flows need different update frequency, some must be updated in real-time (for example transaction/events) while for others less than once a day update is enough (for example status information). The Overall Visibility Index is evaluated summing all of the nodes N of which the supply chain is made, and the contribution of any is weighted:

$$Node\_overall\_visibility_k = \sqrt{Node\_visibility\_quantity_k \cdot Node\_visibility\_quality_k}$$

$$SC\_overall\_visibility = \sum_{k=1}^{N} Node\_overall\_visibility_k \cdot W_k$$

According to the Caridi and the other authors, the weight W_k is based on three criteria:

- Localization in the supply chain, as the distance of the node from the supply chain leader: the nodes which are nearer to the focal company are much more critical than the distant ones, their operations are more connected to those of the leader of the chain, so the relevance (i.e. the weight) is higher. Also, the degree of vertical integration, as the amount of activities directly managed and controlled by an organization, affects the "real" distance between two companies. As shown in Figure 1.1(a) second tier supplier has little relevance for the focal company, while in Figure 1.1(b) W and X have much more weight, and the supply chain leader has greater interest in having visibility of those nodes than firms A and B that are directly connected.
- Significance, as value of the goods supplied: the idea is the same of what discussed in the former paragraph, the more the focal company interacts (i.e. buys/sells) from another firm, the more it should be interested in having visibility of this organization.
- Criticality, measured using a qualitative approach, combining two characteristics: the supply risk and the impact on profits.

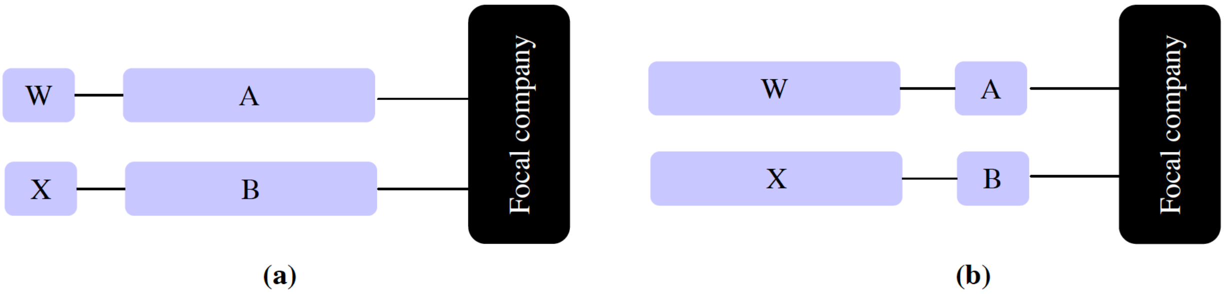


Figure 1.1 Cases of upstream suppliers with different weight for the focal company (Source: Caridi et al., 2010)

The results obtained are several, with a common pattern that can be observed. First, there seems to be a direct proportionality between the quality of the collected information and the quantity of the available one. So, this mean that greater information requires better ICT solutions that will lead to a better quality of information. Second, the focal company has no visibility on second-tier firms, but just on its direct suppliers or customers. At last, vertical integration affects the level of visibility: in fact, with a low degree of vertical integration, firms must make a trade-off between a higher need of better visibility and a higher cost that would generate investing on it. The common consequence is a reluctance by the companies to invest.

1.2 The process-oriented approach to measure effectiveness of supply chain visibility

End-to-end supply chain visibility enable partners to achieve a higher level of market responsiveness and mitigate the risk of disruptions to the flows of materials and products (Wei and Wang, 2010). Moreover, end-to-end visibility is highly recommended to reduce the risk of supply chain failure and to improve analytics of the supply chain (KPMG International, 2016). The lack of common metrics for all supply chains is identified as a crucial concern and challenge for managers, and it causes a low degree of development in this area for organizations.

The metrics to evaluate the effectiveness of supply chain visibility can be synthesized by the process-oriented approach. Its main focus is on the interrelationship between information, technology and business processes, and this approach is identified as a useful theoretical framework to evaluate the significance of information and technology in terms of critical improvements (Visich et al., 2009), which are classified as:

- Automational: it refers to the use of technology to substitute labor in the processes. Moreover, the automational effect is the ability to capture and transfer required information by means of ICT.
- Informational: it emphasizes the management of information and mainly refers to collecting, storing, processing, and forwarding information for the purpose of capturing process information. It also refers to the quality of information collected and distributed among supply chain members.
- Transformational: it relates to the application of information to facilitate and support business process innovation and transformation. It is analogous to the utilization of information and accordingly reflects the alignment of information with business processes in order to improve operational efficiency or increase strategic competences.

This classification is in contrast with assumptions proposed by most of the literature, for which supply chain visibility has a direct impact only on automational and informational characteristics. Therefore, this new classification enables firms to evaluate the extent to which they excel in terms of accessible, high quality and useful information.

The process-oriented approach employed allows to express the importance of information accessibility as an automational characteristic, the quality of information as an informational characteristic, and the usefulness of the information as a transformational aspect of supply chain visibility (Somapa et al., 2017).

1.3 The Bullwhip Effect – a possible consequence of bad visibility

Having a good degree of visibility in the supply chain can reduce the Bullwhip Effect and its impact on inventory level and customer service of a firm. The Bullwhip Effect is a supply chain phenomenon in which order volatility increases moving upstream in the supply chain. Variability in upstream levels is influenced, and can be enlarged, by factors like demand autocorrelation (as the presence of correlation between demand values of the same product) and cross-correlation (as the presence of correlation between demand values of different products), price sensitivity, and demand forecasting. Because volatility and unpredictability make production and supply chain planning difficult, the Bullwhip Effect is generally regarded as an undesirable phenomenon [2].

The more information is shared, the more the Bullwhip Effect can be mitigated (Ouyang, 2007; Trapero et al., 2012). The implementation of policies like Vendor Managed Inventory (VMI), is one of the most effective ways to avoid information distortion, keeping in count how and where the Bullwhip Effect is detected. In many works of the literature is observed that the bounded rationality of the people, defined as a cognitive limitation, is a source for taking inaccurate decisions, that could lead to an increase of the Bullwhip Effect. In particular, it was suggested that the Bullwhip Effect in the supply chain is 80% people centered and only 20% technology centered (Andraski, 1994). Instability and variability on the supply chain is amplified by humans overreacting to backlog and shortages. According to a study, the Bullwhip Effect is related to the fact that decision makers are not able to think systematically (Senge and Sterman, 1992).

The principal effects the Bullwhip Effect has on the supply chain are an increase in demand variability and inventory holding costs, due to an increase in safety stocks, and a decrease in customer service level and revenues (Brandimarte and Zotteri, 2007).

To better understand the various topics related to the Bullwhip Effect, a simulation game called the Beer Game can be used. It was created by a group of MIT professors in the early 1960s, and it is used nowadays in the best business schools to better assess the problematics that can be caused by lack of information and troubles with decision-making. In this game four supply chain levels of a beer company are involved: the retailer, the wholesaler, the distributor and the manufacturer. The goal of the game implies fulfilling incoming orders of beer by placing orders to the next upstream tier. In addition, lead times are deterministic, and penalties are given for backorders and for excesses in inventory. Besides the order request upstream, there must not be information exchange between the four levels. Typically, in the classic configuration of the game the demand of customers, detected only by the retailer, is stable until it doubles itself and remains steady throughout the rest of the game. The lack of information exchange in most of the case will amplify variability, and so the bullwhip effect, through the supply chain, having maximum effect on the manufacturer (Figure 1.2). In fact, every level of the supply chain will try to forecast the demand ordering more at the upstream tier to be covered, especially where there is an increase of requests downstream. In the worst-case scenario there may be two outcomes: an inventory full of stock that is hard to get rid of, or a huge demand back-log that will slowly be fulfilled. These two outcomes of the Beer Game show exactly how and why Bullwhip Effect exist, and it can be smoothed by an increase of quantity and quality of information exchanged.

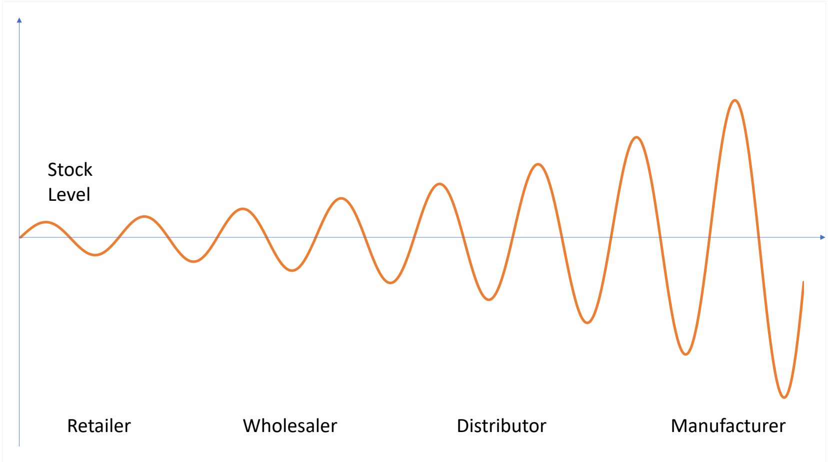


Figure 1.2 The Bullwhip Effect - Consequences on Stock Level (Adapted from: Essays UK, 2018 [3])

1.4 Social Responsibility as a key aspect for increasing supply chain visibility

In addition to delivery, consumers want to know more about how the products they purchase are being made and where is located the production plant. Thus, companies are facing an emerging business challenge, that is to create transparency about Social Responsibility processes in their supply chain. As a statement by Patagonia's director of environmental strategy: "Transparency is really becoming an expectation now. People want to know more about the supply chain making the products they're buying" [4]. But the topic they're dealing with is how much information to give to external stakeholders (Marshall et al., 2016), with which a coordinated assessment must be made on which data could be valuable for them. In order to build a transparent supply chain, a company has to gain visibility into its supply chain and determine what information to disclose to consumers.

A study made by The Sustainability Consortium [5] shows that companies have limited visibility into their supply chain, as 81% of the 1700 organizations surveyed lacked full visibility.

The evaluation of Social Responsibility by the consumer can be motivated by various social preferences, such as altruism, inequality aversion and in particular indirect reciprocity, which is defined as “the return from a social investment in another, from someone other than the recipient of the beneficence” (Alexander, 1987). These consumers, who care about this issue, would be willing to reward a company for its active engagement in improving practices in supply chain, like ensuring the proper treatment of its workers.

Another aspect to consider is prosociality, which is defined as the extent to which the individual is willing to sacrifice her own benefit to improve the payoff of another, and it’s strongly linked to a person’s attention to Social Responsibility (Kraft et al., 2018).

One of the key elements of Kraft and others’ study is that consumers’ valuations increase with a higher level of supply chain visibility, and it is especially true when uncertainty is used as a justification not to pay for Social Responsibility. Therefore, it is highlighted a potential revenue benefit when full visibility is achieved, and so companies have an incentive in creating a more transparent supply chain.

Greater visibility, to themselves and to the public, can help companies reducing uncertainty about Social Responsibility in their supply chains: for example, to better assess the SR performance of its supply chain Hewlett-Packard monitors its suppliers on a monthly basis [6]. Showing information about organization’s processes may increase operational efficiency and customers’ perceptions of service value (Buell et al., 2016).

Gaining visibility can be costly and time consuming (Doorey, 2011), but recent events, like Foxconn workers suicide rate increase in 2010 due to labor conditions, and the garment-factory Rana Plaza collapse in Bangladesh in 2013, have emphasized the need for organizations around the world to improve visibility.

A potential market benefit for greater visibility can be achieved into a supply chain that operates in developing countries, where transparency is lacking, and labor is often subject to poor economic conditions.

For example, in an experiment in the coffee industry of 2015, it is shown that consumers are willing to pay up to a 9% premium for otherwise identical package with a fair-trade label (Hainmueller et al., 2015).

Future directions of this topic indicate that consumers will likely further reward companies which are proactive in providing good visibility into their supply chain, and a lack of transparency might be interpreted as the organization is hiding undesirable information to the public.

1.5 Tracking technology – crucial for achieving full visibility

An increasing availability of real-time data is changing the decision-making process in supply chain. Due to a better understanding of demand information and inventory location, costs can be significantly reduced by replacing product flow with information flow. (Butner, 2010)

Organizations are trying to reduce risks by using tracking technology, that can generate huge amount of data useful for enhancement in workflow management, security, productivity, quality, customer service, etc. (Delen et al., 2007; Musa et al., 2014).

The diffusion of tracking technologies is not only determined by the characteristics of the organization, but also supply chain network and product characteristics. As the scale of the supply chain network grows, more data is available, increasing both the difficulty to process the information and the potential benefits associated with accurately interpreting this data.

Tracking technologies provide valuable data to companies but also to customers, that have access to significant real-time information about the product or service they purchased. Before giving information to customers, raw data must be processed, and this could mean a significant reduction in benefits due to an increase in time and cost investments.

Furthermore, these technologies offer various value propositions by providing information along three dimensions (Figure 1.3) (Basole and Nowak, 2016):

- *Context* is defined as information that can be used to characterize the situation of entities that are considered relevant to the interaction between a user and an application. Location, identity, state of individuals and physical objects are considered as context.

- *Reach* can be defined as radius of information perspective and access a firm has into its supply chain. This dimension has increased at a high pace during the years, allowing organizations to better forecast and schedule their activities.
- *Periodicity* is the frequency by which information is collected and provided. Advanced sensors, based on RFID technology, can gather massive volume of data and provide it almost in real time.

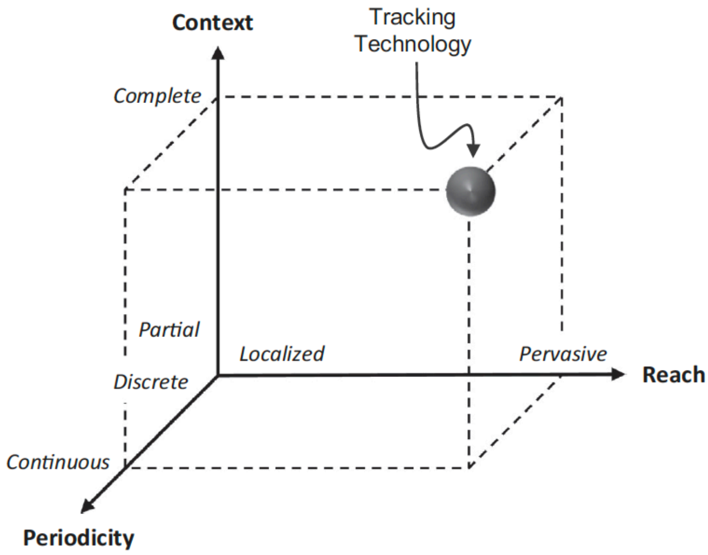


Figure 1.3 Three dimensions of information (Source: Basole et al., 2016)

Therefore, tracking technologies enable firms to shift from receiving local periodic snapshots of their operations to a fully contextualized view of the supply chain, with a high frequency collection and provision of information.

Another crucial aspect of these technologies is the protection from opportunistic behavior. In fact, a better integration between organizations thanks to these systems allows them to increase specific investment which would not be possible if there is a chance that one of the two is having an opportunistic attitude.

Basole and other authors in their work of 2016 make an analysis on how the supply chain system within which a firm operates influences tracking technology adoption, by comparing transaction cost theory and institutional theory. The former proposes that organizations will select, within a set of options, the most efficient technology that allows a minimization of costs associated with a transaction. The latter indicates that decision-making is strongly influenced by norms, values and traditions external to the organization: in fact, the system surrounding a firm includes not only its partners, but also competitors and regulators, which may play a significant role in tracking technologies' initiation, as evaluation of potential benefits and improvement in performance, and then adoption, as decision to allocate resources and physical acquisition.

These two theories are complementary, each fill the gaps of the other. Transaction cost theory highlights that a firm will always choose the technology that maximizes efficiency, while institutional theory can account for those situations in which the firm must implement an alternative technology requested by a customer. Combined, these two theories provide a framework to study technology assimilation.

With no coordination of information transmission, it is difficult to achieve efficient results with tracking technologies. In fact, it is necessary to answer several critical questions, during the phase of initiation and so before the actual adoption, about requirements needed, relevant goods to apply tracking on, and above all which information is needed, and among available ones which is truly valuable for the organization.

Tracking systems can record easy information like location, time of departure and arrival, but in specific occasions it is required to store data about temperature, humidity, vibration and more additional attributes, in order to prevent unnoticed damage and ensure product quality (Shamsuzzoha et al., 2013).

More specifically, a distinction has to be made between the needs of inbound and outbound logistics tracking. Inbound logistics is relevant for organizations because it can affect also outbound. In fact, following the flow of raw goods to the plant can prevent problems in scheduled manufacturing activities, that can cause delay in production, and so distribution to final customers. Inbound deliveries are worth relatively less than final product and it is not equally important to know the exact location, so monitoring through the implementation of a checkpoint system, based on automatic scanning of barcodes whenever there is a move to the next stage of the supply chain, can be enough. On the other hand, outbound logistics involves final product, which is more valuable and may need to be tracked with precision, so more expensive technology is needed, like GPS tracking devices, Radio Frequency Identification tags, better known as RFID (Shamsuzzoha et al., 2015). Using only one technology often is not enough to satisfy the company’s requirements. The best solution would be using a mix of those technologies, having considered the trade-off between actual benefits and cost of implementation and maintenance.

The aim of the management of material flow inbound and outbound is to achieve a competitive service level minimizing logistics cost. The service level is the company’s ability to respond demands and it can be expressed with multiple definitions. Service level can be divided in two types (Brandimarte and Zotteri, 2007):

- Type I Service Level is an ex post metric, and it measures the probability of meeting demand, so the probability of avoiding stockouts;
- Type II Service Level is an ex ante metric, and it is a ratio between the demand expected to serve and the demand expected to face.

1.5.1 Barcodes

Present-day logistics is based on the use of barcodes, particularly warehouse management. This technology is fundamental to keep track of stock, thanks to optical scanners that read the code and transfer data to the warehouse management systems. It is largely used because it is the cheapest and easiest method.

In this field GS1 is the global standard, spread in more than 150 countries. This standard can help organizations to work in a more integrated way, making easier the communication and the information sharing, increasing efficiency and creating value for both business partners.

There are various kinds of barcodes, depending on the size of the unit to move and on the needs of who is using it (Figure 1.4). With the goal to assign the right barcode to each group of items, GS1 has divided the units in three categories [7]:

- Consumer unit: small barcodes that can be applied directly on the finished good to be read by the cash register, without taking much space on the label. They carry information that might be useful to the final consumer. GS1 QR codes and GS1 Databar are the most common in this category, together with EAN, which is the most-known 13-digit code.

- Packaging unit: medium size barcodes applied on the boxes that carry the goods. These barcodes cannot be read by the cash register. The most common is GS1 ITF-14, with 14 digits that report company code and packaging code.
- Logistic unit: large barcodes that allow to track pallets until the units inside will be decomposed. These codes have to be large and easily findable. Serial Shipping Container Code (GS1 SSCC or GS1-128) is the most used, and it is composed by 18 digits.

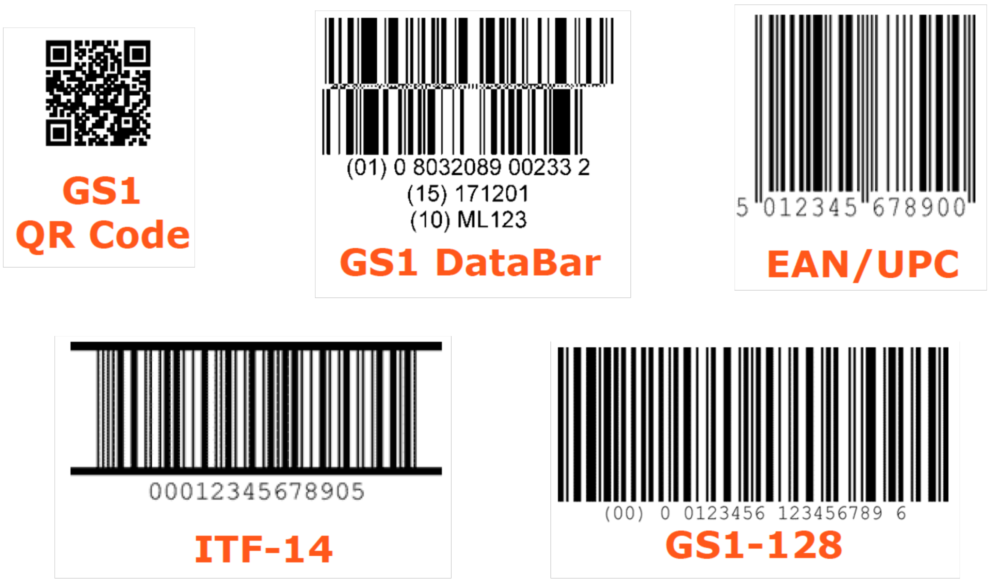


Figure 1.4 Examples of GS1 standard barcodes (Source: GS1)

1.5.2 Radio-Frequency Identification – RFID

The RFID technology is more accurate than barcodes, because it uses radio signals to exchange data between a reader and a transponder (typically a tag or a smart label) located on moving objects, in order to identify, classify and track the goods. Usually, RFID systems consists in: a tag or smart label, a reader and an antenna (Figure 1.5). In the tag there are an integrated circuit and an antenna, which are used to transmit data to the reader also called interrogator. The reader then converts waves to data usable by the organization, which are then transferred to the information systems and stored in databases [8].

The advantages that RFID has over barcodes are various: RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner.

Moreover, it gives the chance to read/write data and to have automatic reading, it is tiny, robust and reusable. The main advantage that barcodes have over RFID is economic convenience, together with ease-of-use. [7]

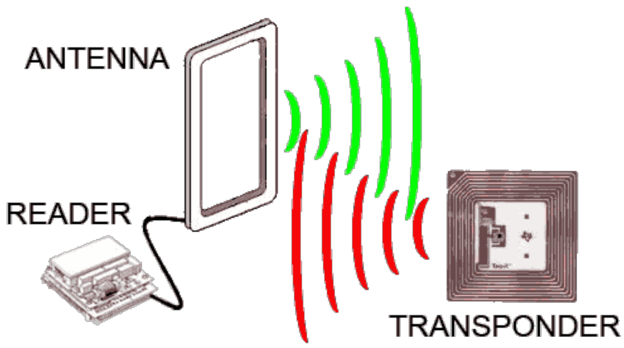


Figure 1.5 Elements on which RFID is based (Source: researchgate.net)

1.5.3 Near Field Communication – NFC

This technology can be considered an evolution of RFID. It allows wireless communication and data exchange between digital devices in close proximity to each other. Devices using NFC technology can be passive or active [9]. The former is a device that can only contain information but cannot read it, while the latter can read it, send it and even alter what is on the passive device, if authorized to make changes.

The adoption of this technology is rising, because of the convenience of having a smartphone that can act like a reader and can send instantaneously data to cloud databases via LTE connection (Figure 1.6).

Figure 1.6 NFC ease-of-use (Source: secureidnews.com)

1.6 Current state of Supply Chain Visibility: best-in-class example

In an exceptionally dynamic world, companies are facing great challenges in the supply chain environment. In fact, competition in the globalization era has shifted from a "company vs company" perspective to a "supply chain vs supply chain" one (Lambert and Cooper, 2000), due to factors like product life-cycle contraction, market volatility and mainly to externalization of all those activities which are not core competences of the organization (Prahalad and Hamel, 1990). Therefore, supply chain management must not be considered by companies as just a tool, but it has to be a competitive weapon in organizations' medium-long period strategy (Ketchen and Hult, 2007). The main key to achieve an advantage in this field is visibility, and so it must be distinctive and unique as much as possible (Barratt and Oke, 2007).

One company that is way ahead of other firms in this field is Amazon. It is one of the best in class organizations in visibility and transparency, guaranteeing its customers not only the possibility to know the status of the delivery of their product, but a series of secondary services that have put this company in the first place for customer's satisfaction for the fifth straight year in the UK [10].

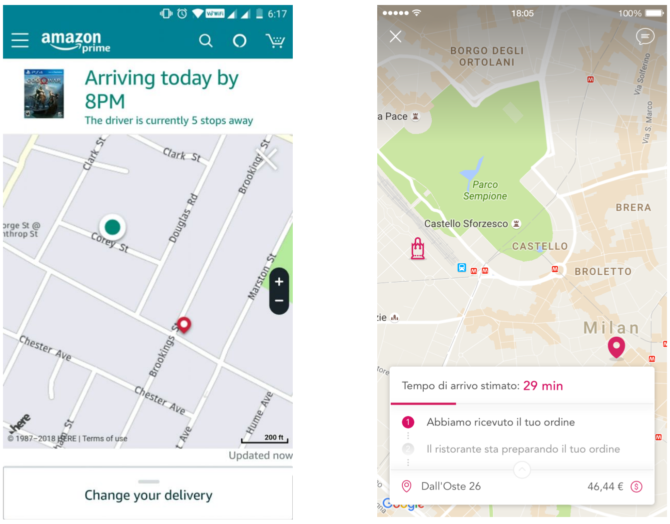
This set of services is simple, and firm of other industries are trying to adapt to it, to go after customers' requests. Amazon guarantees maximum transparency and delivery reliability with seamless communication with its customers:

1. before actual purchase of the product it gives an Available To Promise date, which is a range of one/two days in which the delivery will occur;
2. it gives precise tracking information through the carrier in charge of the delivery;
3. it has a proactive delay management: in case of a delay of the delivery it promptly warns customer, apologizing for the inconvenience, and giving a new delivery date.

These three elements are highly appreciated by customers, which are asking for the same treatment also by businesses from other industries, and automotive is one of those.

Amazon has one main focus: the customer. Every investment is evaluated in terms of benefits that consumers could get, and always trying to find new and better ways to improve their experience. Although its capabilities may be out of reach for average businesses, this customer-centric model should provide inspiration for other firms that could gain a great benefit.

In addition, during 2018 Amazon has introduced for USA customers a new feature of localization of the delivery driver on the map [11]. It is called Amazon Map Tracking, and it provides live updates on drivers' delivery routes, along with how many stops they have to cover before the actual consignment (Figure 1.7a). Food delivery companies like Foodora or JustEat were already using this map visualization feature, which has become a core business for them, because customers want to be able to check the exact location of the rider that is carrying their products (Figure 1.7b).



(a) (b)

Figure 1.7 Screenshots of Amazon Map Tracking (a) and Foodora (b) live localization of the delivery (Source: Business Insider, 2018)

Automotive is one of those industries in which a change in this field is happening, but slowly and not easily, because the selling method is based, in most of the cases, on an intermediary, the dealer, which owns direct contacts with the final customer, and gives him information. Moreover, there is a long procedure for the dealer to deliver the car to the final customer even if the vehicle has arrived. In fact, some days are needed to complete procedures like vehicle registration and financing request, typically a week.

However, customers are requesting an Amazon-like treatment because the expense is much higher and the time they have to wait is longer than a typical order on Jeff Bezos' platform. It is necessary though to clarify that one of Amazon success factor is a unique supply chain management in their fulfillment centers and then in outbound, not having a production phase upstream that could influence negatively their performances. Companies in the automotive industry are trying to move towards a greater transparency: Opel and Audi for example developed an app for their final customers, to keep them updated about the status of their vehicle delivery, allowing these firms to go beyond the problem of the intermediary, and having direct contact with consumers.

This is one of the dares that companies throughout all industries are dealing with, an ambition of the final customer to have more and more information about the status of the delivery of their product.

1.7 Tracking technology used in automotive industry

Automotive industry's highly complex structure puts high demands on logistics and associated service level. This industry is also characterized by a large number of different kinds of products and high volumes of fluctuating production, and the supply chain always needs to meet high standards of quality and flexibility. New communication methods are necessary to replace the traditional ones, which see shortcomings due to globalization, variability of demand, production on order, sequential deliveries and many other processes (Stasa et al., 2016). Electronic Data Interchange (EDI) is a new technology that has established and has become standard for organizations. It is the computer-to-computer exchange of business documents (for example purchase orders, invoices, inventory documents) in a standard electronic format between business partners, and it replaces email, which is also an electronic approach but must be handled by people rather than computers. Moving to this much more standardized method of exchanging documents increases processing speed, reduces costs and errors, and improves relationship with partners.

There are basically three steps to send an EDI document (Figure 1.8):

1. Prepare the documents to be sent: to collect and organize data through sources like human data entry, exporting PC-based data from databases and spreadsheets, etc.;

2. Translate the documents into EDI format: it is necessary to convert internal data format into EDI standard format, with a translation software appropriate for the environment;
3. Connect and transmit EDI documents to business partner: there are several ways, like connecting to a secure internet protocol or an EDI Network Provider or even a combination of both.

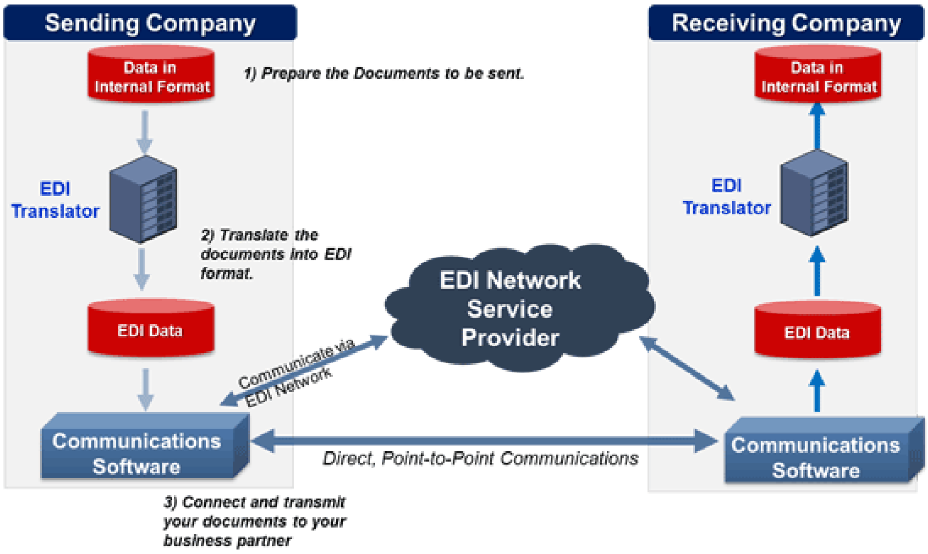


Figure 1.8 EDI - Information Exchange Process (Source: Stasa et al., 2016)

Another standard that is asserting in the supply chain world is Electronic Product Code Global Network (EPCglobal Network), which is a set of technologies, enabling business partners to monitor product movement in the logistic chain (Traub, 2014). It supports improvement of organizations efficiency by enabling dynamic and accurate information distribution in real time. The advantages that it ensures for the automotive industry are costs reduction and optimization of the process in the goods delivery. It is then assumed that most vendors will be able to apply a Just In Time process to deliver to their customers, and in addition they will share their data and reports electronically with their own suppliers as well as with their customers.

Within the collection of technologies that EPCglobal Network comprises, the most relevant can be considered Electronic Product Code Information Systems (EPCIS) especially designed to exchange large volumes of serialized data (Stasa et al., 2016). The goal of EPCIS is to enable applications to create and share visibility event data, both within and across enterprises. It could be considered as a key enabling technology to be primarily implemented in such areas where it is necessary to show the history of the production, transportation, ensure authenticity and higher level of safety of the products. EPCIS is a GS1 standard that enables trading partners to share information about physical movement and status of products as they travel through the supply chain, from business to business or even from business to consumer. The databases and information systems that compose the back-end application play a relevant role in implementation of traceability and visibility services, because there is a need to develop interface for data exchanging between RFID system and ERP systems (Kang and Lee, 2013). The events that EPCIS registers must be presented in an understandable form for software components, and they may relate to identification of one or more objects which are identified by the EPC, the aggregation of objects into higher logistic units, business transaction or a simple inventory quantity of objects of that type.

The automotive industry is one of the most complicated and turbulent, which is associated with high costs and investments. In this environment there is a very strong competition and any hesitation entails high costs (Stasa et al., 2016). The current state of the automotive industry requires faster deliveries of increasingly complex products, throughout the supply chain form all manufacturers and subcontractors. Due to cost reduction this industry was the first where the approach to organizing and managing processes has begun to apply, following the Lean Production pillars. The biggest losses of manufacturers arise from overproduction, stock holding of materials, semi-finished or finished products, and also the loss due to suspended production because of delayed deliveries of goods.

As the work by Stasa reports, these present solutions help to meet strict requirements of automotive industry, ensure traceability and visibility through logistics chain as well as help to find bad habits of employees.

1.8 Literature review

In the following paragraphs a classification has been made of the most significant articles addressing visibility in the automotive supply chain. This topic has an increasing importance, because a good visibility of supplier and customer practices benefits both parts, improving efficiency and reducing extra-cost. Moreover, final consumers are strongly requiring to be more involved in the information exchange processes, for which a reliable visibility is fundamental.

The literature review was conducted by searching for articles that matched the keywords of this work, like outbound visibility, automotive visibility, automotive supply chain, and the combination of all of those. Ten articles were founded, but some of those did not cover properly the topic of this thesis, and so they were rejected. There were four articles among those that were used for the literature review later introduced. These articles cover visibility aspects of the inbound process of materials, analyzing the relationship that companies have with their suppliers and vice versa, how it can be improved through a series of KPIs to monitor and what are the factors that influence the visibility. Moreover, regarding outbound processes, the current state of tracking technology was analyzed, together with the importance of visibility for logistic providers, that reflects on final customers. These articles belong to important scientific journals: *Logistics Research, Materials Today: Proceedings, Information and Communication Technologies and Services, The International Journal of Logistics Management.*

1.8.1 Logistics Performance Measurement System (PMS) for the automotive industry

A study of 2016 (Dornhofer et al., 2016) focuses on the development of a Performance Measurement System (PMS) to better assess effectiveness and efficiency of inbound and in-house logistics processes, within a context of lean logistics. Therefore, visibility and transparency are necessary requirements to provide valuable information with the goal of efficiency improvement. But also, a proper PMS can be seen as a key to create transparency and a trigger for improvement ideas, which could have not been developed if there were not appropriate measurement (Schmitz and Platts, 2004). So, a mutual relationship can be seen between PMS and transparency. In the transition to a lean environment, based on continuous improvement and standardization of the improved concepts, a PMS allowing the comparison of different concepts becomes even more important (Jones et al., 1997).

Dornhofer and the other authors evaluate logistics objectives, considered multi-dimensional, and defined as achievement of cost advantages and realization of service leadership to realize price premiums, reflected on dimensions of increased productivity, quality and customer satisfaction.

Customer satisfaction includes the improvement of customer service, in terms of lead time, on-time delivery, and possibility to have visibility of the status of their vehicle. In this field Japanese manufacturers are leaders, because they focus more on quality and customer satisfaction, while Western automakers tend to emphasize the productivity dimension first. Moreover, in Europe improvements are orientated more towards the short term, in contrast to Japan (Stainer, 1997).

The Performance Measurement System proposed by Dornhofer and the others starts from overall KPIs in top-level dimension Efficiency, Lean Logistics and Perfection, and then broken down in inbound and in-house movements KPIs. Perfection dimension monitors the information quality, that focuses on relevant information for supporting inbound processes or the quality of transportation documents and labeling. A process perspective is integrated into the PMS to increase specificity and facilitate continuous improvement.

The PMS is mainly proposed for the automotive industry, broken down from the logistics objectives to a process module level. Therefore, breaking down resulting KPIs into performance indicators will ensure linkage from strategic level down to the operational level.

1.8.2 Improving supply chain performance by Supplier Development programs through enhanced visibility

The landscape of studies regarding inbound processes of automotive supply chain visibility can include the work of 2018 by Pradhan and other authors. It states that increasing uncertainty brought by market dynamics creates a new panorama of visibility issue, where the existence of proper visibility delivers a seamless operation in supply chain performance, but its absence creates chaos in entire value chain (Pradhan and Routroy, 2018). In presence of Supplier Development (SD, as an established collaborative relationship with suppliers) where the supply chain is leaner, the visibility is a significant governing issue which can produce all the disadvantages of SD, if not dealt properly. Complexities in terms of relationship has been advanced from cooperation to coordination, and now to collaboration either in form of long-term contract or adoption of visibility mechanism (Spekman et al., 1998). This work tries to identify the governing criteria and their articulation to enhance supply chain capability through visibility in presence of well-defined SD program. To better understand the complex relationship between factors an Interpretive Structural Modelling approach (ISM) was applied to an Indian automotive company with a SD program going. These factors are:

1. Product visibility technology adoption: systems that enable tracking the complete life cycle of product activities and processes.
2. Cost leadership: vital parameter, through which organization creates value of competitive advantage for their customers.
3. Market uncertainty: demand volatility and forecast complexity make synchronization difficult.
4. Innovation and quality improvement: better visibility could improve product innovation, in terms of technology or process.
5. Dependency&resource sharing: closer cooperation is required to create valuable surplus in supply chain.
6. Mutual trust: mandatory among supply chain partners to achieve full collaboration.

Through the use of multiple matrix, like Structural Self-Interaction Matrix (SSIM), Initial Reachability Matrix (IRM) and Final Reachability Matrix (FRM), the authors found out that market uncertainty and dependency&resource sharing are the criteria that push for a Supplier Development implementation, followed by the other four factors, responsible to upgrade the value chain to achieve futuristic supply chain performance with greater visibility.

1.8.3 Ensuring the visibility and traceability of items through logistics chain of automotive industry

The previously introduced study by Stasa addresses the importance of the traceability concept, which is fundamental in today's competitive economic environment. The goal of this work is to describe the current situation of technology based on Electronic Product Code, and the development of RFID based track and trace systems for ensuring visibility and traceability of items in the inbound logistics, especially of automotive industry (Stasa et al., 2016). Traceability for serial-level (or item-level) products is a fundamental requirement in this industry (Van Dorp, 2002). As said earlier EPCIS can be considered a key enabling technology, if it's necessary to show multiple information about the products being delivered. However, in the USA it is not the official format for exchanging data, but supply chain partners can still choose it. The remainder of the work is focused on the development of a set of technologies that could be useful for the inbound processes, based on AutoEPCNet. This information system is used to track and trace items marked with RFID tags in logistic chain, and its main functions are processing large-scale event data, enabling history trace services tailored to the auto industry logistic system, and building an information service hub by harnessing RFID technology. Modules can be developed on top of this system:

- Supply Chain Modeler, that facilitates handling and logistical follow-up activities that take place in the chain giving them in a clear and coherent unit;
- Visibility and Analytics Service, that offers to users information about the status of all the partners of the supply chain and creates their clear graphical structure, making possible the detection of downtime and loss of time in different parts of the chain;

- e-Pedigree Service, that describes all necessary data about the product, all phases of the product development, all identification data of the producer and of course product information.

This solution has been deployed in the logistic chain of a car producer in Czech Republic, with benefits in time savings and increase of the service level.

1.8.4 The development of outbound logistics services in the automotive industry

Regarding outbound distribution, the literature offers a study by Rajahonka and others that analyzes this topic from a logistics service provider's (LSP) point of view (Rajahonka and Bask, 2016). In particular how the service models have developed during years of increased outsourcing by automotive manufacturers (Bolumole, 2003), and how innovation in terms of visibility should be introduced in this field.

The roles and strategies of LSPs have been in transition for a couple of decades due to this externalization (Zacharia et al., 2011). As a result of expanding role of providers within supply chains, they developed a variety of optional service strategies and related service models (Bask, 2001) and they are active members of the innovation improvement. Rajahonka and the other authors classify them in assets, skills and capabilities, and customer relationship. It's important to emphasize the role of customers in service innovations, as logistics firm should "think for the customer" and recognize opportunities that may emerge outside traditional business models (Chapman and Soosay, 2003). So, from here comes the necessity to implement visibility innovation strategies with the aim to make possible to customers to see the distribution process steps in the making. Strategic innovation goals are customer-oriented innovations with service modularization and minimization of costs (Shen et al., 2009).

Automobile supply chain has several actors (manufacturers, suppliers, dealers, providers) all with distinct and variable logistics need and requirements (Trappey et al., 2010). Manufacturers have understood that final customers want to be engaged on what is happening in the supply chain, and the focus is on make them able to have information, and this require collaboration with other partners of the chain.

The study by Rajahonka confirms that LSPs can have a proactive role in service innovation and contribute to final customers' satisfaction.

1.9 Research gap

The previously addressed literature review highlights a big presence of works regarding the inbound processes of automotive industry and how visibility can be improved through the implementation of new technologies and adjustment of the present ones. The current literature doesn't cover properly the topics regarding supply chain visibility and tracking in the outbound distribution of the automotive industry, because the works that can be found typically address visibility internal at the production plant or inbound, or they do not examine in depth the degree of visibility that car manufacturers offer to their customers (but also to the dealers) and how it can be improved.

This work's aim is to focus on how distribution for a large automotive manufacturer works, analyzing the main processes and methods for transportation, what is the visibility degree from dealer and customer's side, and how it can be improved. In particular how communication between the parts happen, what are the data exchanged and how improvement can be achieved in this field.

Chapter 2 – Fiat Chrysler Automobiles, brands and divisions

In this chapter there will be a brief introduction about FCA, the company where the thesis work has been conducted, with particular regard to the owned brands, before and after the fusion. Moreover, Supply Chain Management and its divisions will be introduced.

2.1 Company's introduction

Fiat Chrysler Automobiles is a global automotive group engaged in designing, engineering, manufacturing, distributing and selling vehicles, components and production systems worldwide.

FCA is a multinational company incorporated in the Netherlands, with administrative Headquarters in the UK and organized mainly in regional Operations, for the four areas which the world is divided in:

- EMEA: Europe, Middle East, Africa;
- NAFTA: North American Free Trade Agreement (USA, Canada, Mexico);
- LATAM: Latin America;
- APAC: Asia-Pacific.

FCA is currently the 7th car manufacturer in the world, having sold almost five million vehicles during 2017 (Figure 2.1) [12].

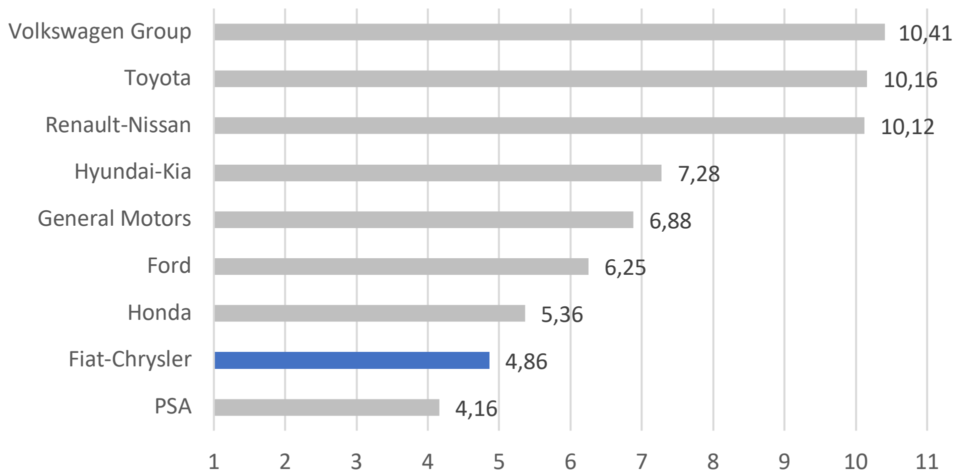


Figure 2.1 Leading motor vehicle manufacturers worldwide in 2017, based on global sales (in million units) (Source: Statista, 2018)

It includes both automotive and components&production systems brands (Figure 2.2). In addition, retail and dealer financing, leasing and rental services related to and in support of the Group's car business are provided through either subsidiaries or financial partners.

FCA is listed on the New York Stock Exchange under the symbol *FCAU* and on the Mercato Telematico Azionario under the symbol *FCA*.

It serves more than 140 markets (with Italy, France, Germany, Spain, United Kingdom and United States being the most relevant) thanks to its 159 operative plants in 40 countries and to its over 200.000 employees spread worldwide (FCA, 2018).

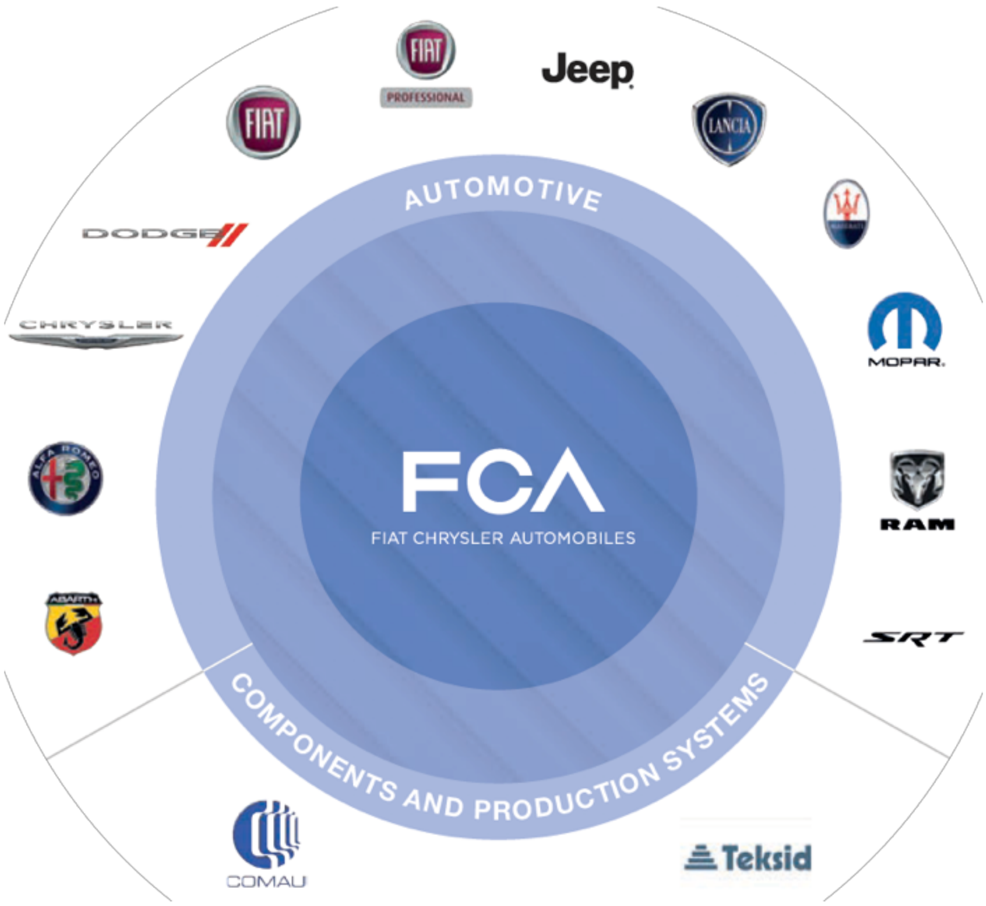


Figure 2.2 FCA's companies (Source: FCA Corporate Presentation, 2018)

2.2 FCA’s automotive Italian Brands

At the end of 20th century historical Italian automotive brands went through deep crisis due mostly to bad management, and the biggest of those companies, FIAT, acquired each one of them, starting from Lancia in 1969. Before the fusion with Chrysler, these companies were all owned by Fiat Group.

Abarth

Founded in 1949 by Karl Abarth – and with a history of records and successes on and off the racetrack – the Abarth brand specializes in performance modification for on-road sports cars.

Since its re-launch in 2007, Abarth has been bringing the elements of the racetrack to customers through its performance kits and production touring and racing versions of several Fiat models.

Abarth is a fundamental point of reference for small supercar lovers.

Alfa Romeo

Since its founding in Milan, in 1910, Alfa has designed and crafted some of the most stylish and exclusive cars in automotive history. That tradition lives on today as Alfa Romeo continues to take an innovative approach to designing automobiles (Figure 2.3).

The market segment in which Alfa Romeo is competing is Premium, as well as Maserati.

Figure 2.3 Alfa Romeo Giulia (on the left) and Stelvio (on the right) (Source: Alfa Romeo Car Configurator)

Fiat

Founded in Italy in 1899, Fiat is rooted in a more than a century-long tradition of designing and making small cars, many of which have become icons for entire generations and accompanied Italy's major economic and social transformations.

The brand is primarily focused on the mini, small and medium vehicle segments, making cars that are functional, easy to drive, affordable and energy efficient, while at the same time also distinguishing themselves for their style and innovative solutions offered (Figure 2.4).

Figure 2.4 Iconic models: Fiat 500 (on the left) and Panda (on the right) (Source: Fiat Car Configurator)

Fiat Professional

With over one hundred years of history, Fiat Professional stands out in the light commercial vehicle industry, providing a wide range of transport solutions, customized to satisfy all business and recreational needs.

The brand also offers a comprehensive range of services and solutions to meet every working need of both large and small businesses.

The Fiat Professional range of vehicles is versatile and reliable, designed to keep professionals on the move.

Lancia

Lancia is one of the oldest Italian automotive brands, founded in 1906 in Turin by Vincenzo Lancia, and property of Fiat since 1969.

The iconic city-car Lancia Ypsilon follows the stylish history of the Lancia brand, and currently it is the only model available in the lineup.

Since 2017, Lancia has returned to focus exclusively on the Italian market.

Maserati

Established in Bologna in 1914, the "Marque of the Trident" offers something uniquely compelling in the world of luxury performance cars.

With a race-bred engineering DNA, every model delivers elegant and sporty design, distinctive Italian style, and that inimitable Maserati engine sound.

In recent years, following an ambitious strategy to expand the product range into the Luxury SUV and High-End Sedan E segments, Maserati has undergone a significant transformation and seen exceptional growth.

Mopar

Established in 1937, Mopar has been transformed into the global service, parts and customer care provider for FCA brand vehicles.

Mopar offers authentic parts and accessories that are engineered together with the same teams that develop the factory-authorized specifications for FCA vehicles, offering a direct connection that no other aftermarket parts company can provide. With its global reach, today the Mopar brand distributes more than 500.000 parts and accessories in over 150 markets around the world.

2.3 FCA's automotive American brands

These brands were previously owned by Chrysler LLC, that was acquired from the Fiat Group starting from 2009. It was a slow process of shares acquisition, ended in 2014, when Fiat completed the process acquiring the entirety of Chrysler LLC, and then giving birth to Fiat Chrysler Automobiles. A key person for this fusion was Sergio Marchionne, CEO of Fiat since 2004, who rebuilt the success of this company after a long period of crisis.

Chrysler

Founded in 1925, the Chrysler brand today is primarily focused on the minivan and full-size car segments in North America. Through succession of innovative products Chrysler offers a perfect balance of substance and style that continues to solidify its standing as a leader in design, engineering and value.

Dodge

Founded in 1914, Dodge offers a complete lineup of performance vehicles each of which stands out in its segment. The brand has been making bold, aggressive, distinctive cars for more than a century.

From muscle cars to crossovers and full-size SUVs, the Dodge brand's full lineup of models delivers best-in-class horsepower, technology and capability.

Jeep

Founded in 1941, the Jeep brand is a global icon, recognized around the world for its SUVs and its unmatched off-road capability (Figure 2.5).

In recent years, with a clear strategy of expanding both its product range and its global presence, Jeep has gone through a profound transformation and exceptional period of growth.

Figure 2.5 Jeep Compass (on the left) and Renegade (on the right) (Source: Jeep Car Configurator)

RAM

Since its launch as a stand-alone division in 2009, the RAM brand has emerged as a key player in the industry with America's longest-lasting line of pickups and a full range of light commercial vans.

Separating the brand from Dodge and creating a distinct identity has allowed the RAM brand to focus on its core business, markets and customers.

By investing substantially in innovation and new products, RAM has proven to be capable, efficient and durable, and continues to beat the competition in capturing the most sought-after titles.

2.4 FCA's components brands

In addition to the automotive brands discussed in the previous paragraphs, FCA owns companies in the components industry too. Magneti Marelli will not be mentioned because of the property transfer to the Japanese company Calsonic Kansei at the end of 2018 [13].

Comau

Headquartered in Turin, this brand combines innovative engineering solutions with enabling technologies to help companies leverage the full potential of digital manufacturing.

The portfolio includes joining, assembly and machining solutions for traditional and electric vehicles, robotized manufacturing systems, a complete family of robots with extensive range and payload configurations, autonomous logistics, and asset optimization services with real-time monitoring and control capabilities.

Teksid

One of the world's largest producers of gray and nodular iron castings, Teksid is also a leader in production technologies for aluminum cylinder heads and engine components.

Teksid's position as a world leader is built on long-standing experience in the sector, cutting-edge automation and continuous updating of technologies that ensure the highest quality of standards are maintained.

High technical standards and close collaboration and integration with the product development activities of customers, to meet their specific needs, are major competitive advantages for the company.

2.5 FCA – Supply Chain Management division

Supply Chain Management's aim is to coordinate and balance commercial and industrial needs, guaranteeing equilibrium between demand (customer orders) and installed capacity (in production plants and at suppliers) in order to maximize profit.

Due to FCA being a global reality, SCM role is both on a Regional level and on a Global level.

This structure covers the entire process, from orders collection to vehicle distribution and delivery, managing capacity and materials planning.

SCM is composed by ten divisions, which constantly interacts with each other for a macro-goal, despite having different micro-goals and activities (Figure 2.6).

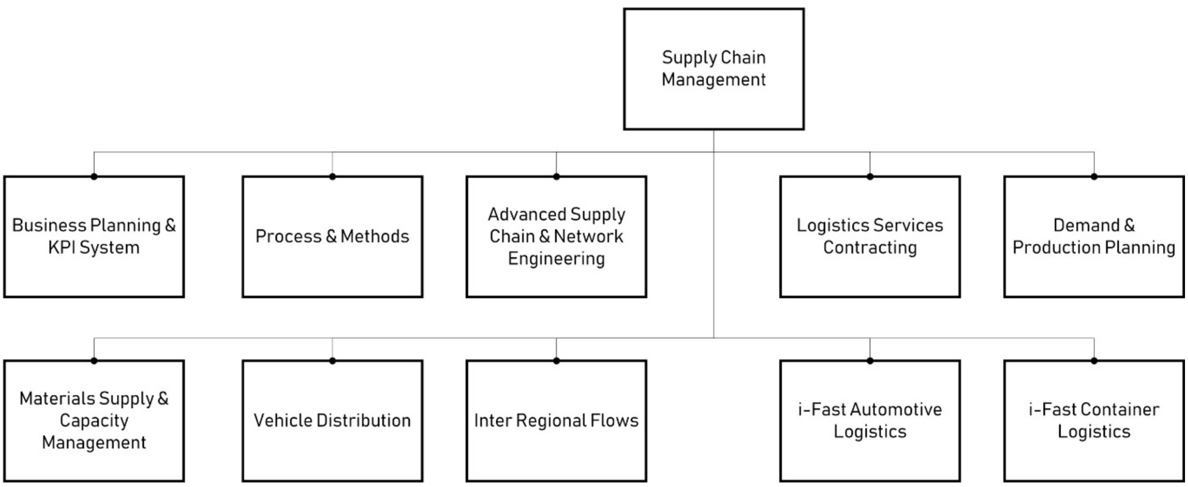


Figure 2.6 Supply Chain Management divisions (Source: FCA Supply Chain Academy, 2018)

- **Business Planning & KPI System**: it supports SCM in cross activities; it coordinates benchmarking activities with competitors from automotive or other industrial sectors; it monitors supply chain's KPIs;
- **Process & Methods**: it is the division where the thesis work has been drawn up. Its main activity is the development of initiatives that ensure alignment to industry's benchmarks, while coordinating homogenously the regions. It is divided in four areas:
  - Commercial Process: to support sales and production planning, collection of market orders, forecasting systems, billing to dealers and markets;
  - Industrial Process: material planning system and scheduling orders in production, carriers planning management and industrial performance indicators;
  - Outbound and Special Projects: product configuration systems and vehicles flows from compound to dealer;
  - Academy: training system to develop new skills and competencies.
- **Advanced Supply Chain & Network Engineering**: it focuses on continuous development of the logistic aspects during vehicle life-cycle, trying to build an efficient but sustainable network;
- **Logistics Services Contracting**: it defines strategies for inbound and outbound transportation, trying to reach the highest service level while keeping costs in budget;
- **Demand & Production Planning**: it manages production volumes allocation to guarantee Retail sales and Wholesales forecasts; it monitors and compares production status to identify eventual shortfalls;
- **Materials Supply & Capacity Management**: it works with demand planning team and suppliers to guarantee operative plans feasibility; it evaluates required actions with suppliers to satisfy commercial demand;
- **Vehicle Distribution**: it manages transportation from production plant to market compound; it focuses on quality of both storage and transport;

- **Inter-Regional Flows**: it manages materials and components flow between the four regions; it optimizes replenishment, packaging, shipment and invoicing of direct material;
- **i-Fast Automotive Logistics**: it guarantees transportation and distribution of FCA vehicles in Italy and Europe through his own fleet, or through third party providers, ensuring all necessary actions in order to maintain the ISO 9001 certification;
- **i-Fast Container Logistics**: it manages collection of materials from suppliers and transportation through containers to production plants.

Chapter 3 – FCA's insights: orders, production plants and distribution

In this chapter an overview will be given on the main processes in which FCA is involved, first introducing its customers, then explaining how a vehicle can be ordered by the final consumer. Later on, a deeper analysis on how outbound distribution works for FCA, and more generally for most automotive companies. In particular for FCA a list has been made of the nodes of the big network necessary to reach all their customers, the production sites and where the vehicles are stored waiting for the delivery, the most used methods and other elements necessary for further investigations.

3.1 Sales channels and final customers

As seen previously, FCA is a global group that includes many brands, and that means having different typologies of sales channels and customers, each of them with unique needs and expectations.

Sales channel, defined as the way of bringing products to market so that they can be purchased by consumers [14], for FCA are:

- Dealer: a network of independent entrepreneurs with the goal to link FCA and final customers. Dealers manage also sales to small businesses;
- Rent A Car (RAC): rental companies;
- Converters: professionals that work on Fiat Professional vehicles, transforming them into campers;
- Direct sales: a network of owned dealer that have direct contact with customers. The most known is Mirafiori Motor Village.

The first category is the most relevant one, with the most weight in FCA sales. This category will be considered for further analysis in this work.

Then there are final customers: private and employees that mainly purchase their vehicles through dealer and FCA owned dealers, government that may request vehicles through public bids, and business fleets.

Moreover, there are two categories of vehicles: new and used. The former is composed by cars that are produced and then sold to final customers in the classical way, while the latter is composed by vehicles that come back from a previous formula of renting to governments, business and private customers, or from an exchange formula, in which the customer return his old car to get a new one.

3.2 Order-To-Delivery process

Order-To-Delivery (OTD) is the process within which automotive companies operate (Figure 3.1). It begins with the dealer taking an order by the final customer and it ends when the customer receives his vehicle. It must be noted that not every car is sold with this method, because the dealer makes his forecast and orders a large quantity of vehicles to the manufacturer without having a final customer, to have stock ready at its compound. Moreover, in the North America market it's very unusual that a customer orders his car and waits for the manufacturing process, because typically he will buy a vehicle after having had a look of what is on the dealer's compound (Stablein et al., 2011). Instead, in Europe customers are more willing to wait for the car to be manufactured, because they want to choose their own configuration, and so the vehicle must be produced tailored on his/her requests. However, half of European customers buy vehicles from stock (Volling, Matzke, Grunewald, & Spengler, 2013).

Analyzing the OTD process is interesting because the manufacturer has to adapt to a single customer request of customization with the operational planning that was already in place. Researchers have reported that generally European and Japanese companies have similar OTD processes (Aoki et al., 2014; Staeblein and Aoki, 2015). Generally, the structure of the OTD process for most automotive organizations is: order entry, order bank, order scheduling, order sequencing, manufacturing, distribution to market compound, transportation from market compound to dealer (Zhang et al., 2007).

FCA gives the highest priority to the customer that makes a specific order configuration, and it is called *Final Customer Order* (OCF in company's language). During the visit at the showroom, the dealer notes the requests of the customer for optional elements on the car (like heated seats, glass roof, bigger wheel rim, etc.), then in the back-office, the order will be loaded through the Dealer Management System (DMS) on the connected

FCA's system LINK, and it will return a first approximation of the Estimated Time of Arrival (ETA) of the vehicle (focus in next chapter). The OCF is then paired to alert FCA that this particular vehicle has already a final customer and so it must be prioritized. After that, considering all of the production constraints, the order is scheduled by the information system within the Operational Planning (PO in the company's language), and a confirmation date is given to the dealer. The confirmation date consists in the Friday of the week in which the vehicle will be produced. Automakers allow their customer to amend the configuration of the vehicle, unless it has reached a point in time where specifications cannot be altered due to production constraints.

Moreover, most manufacturers (FCA included) allow dealers to fulfill a customer request with an unsold vehicle or replenishment order in the pipeline taken from another dealer (Williams and Bozon, 2006).

After all these order activities the vehicles is then manufactured in one of the production plants owned by FCA, and then distributed to the dealer and the customer (this process will be discussed in later paragraphs). The entire process ends when the dealer declares that the delivery to the final customer took place (CCF).

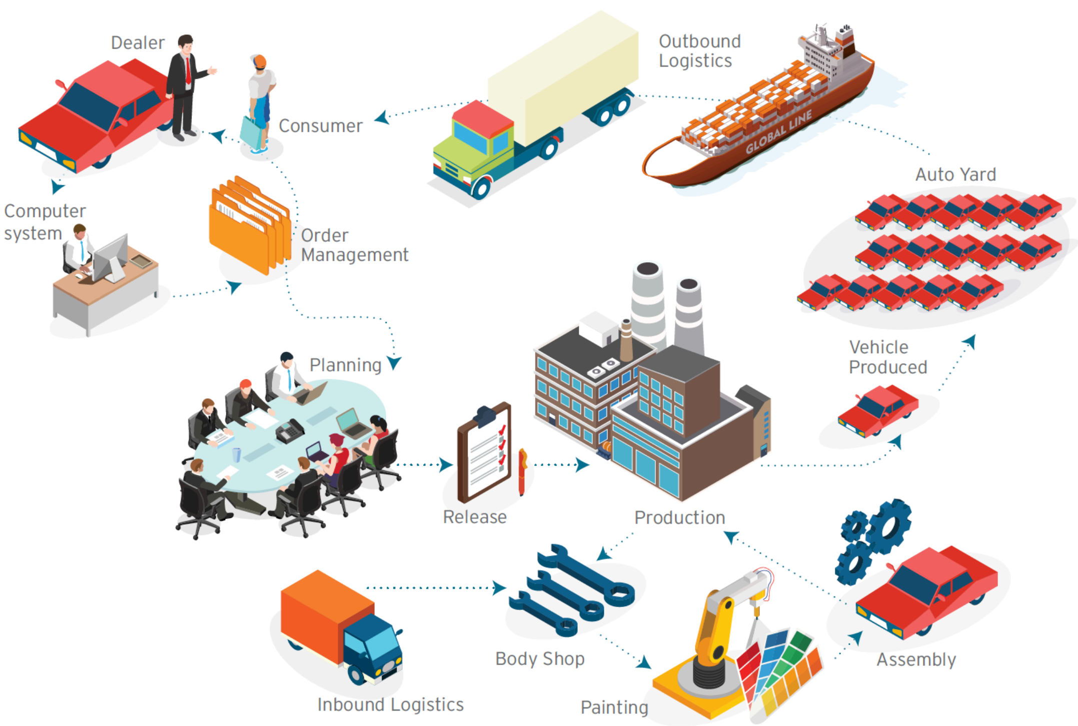


Figure 3.1 The Order To Delivery process (Source: Cognizant 20-20 Insights)

3.3 Automotive production plants

Throughout the years automotive manufacturers had to adapt their production plants to an increased chance of customization for the final consumers, so new techniques and methods had to be adopted, and new sites had to be opened. This proved to be necessary due to spacing/logistical reasons (equipment had to be arranged properly within an appropriate building) and due to cultural reasons. Indeed, workers accustomed to executing their job in a certain way, would likely refuse to change methods. One example that proves this statement is the opening of Fiat plant in Southern Italy, more precisely in Melfi in 1993. In this region there were new workers, without a past in vehicles assembly, that could be trained from the beginning, then avoiding the cultural aspect of change.

For the construction of a new plant, the manufacturers focused on these guidelines:

- Modular production;
- Suppliers' integration;
- Just In Time and Lean manufacturing application;
- Throughput time reduction.

To respect Lean principles for the assembly of a vehicle, inbound logistics efficiency needs to be extremely efficient. Problems in the delivery, like delays or wrong part number shipped, can cause the production line to stop completely in the worst-case scenario. Production scheduling is tight, and the order portfolio will shape the Operational Planning.

The Operational Planning process is very complex considering the many drivers involved and the peculiarity of the subprocesses. For a correct use of the PO, Supply Chain division needs to manage three parameters: market, model, administration.

3.3.1 FCA production sites

Distribution largely depends on where the vehicles are assembled. FCA has production plants located in all the four regions: EMEA, NAFTA, LATAM, APAC

Europe is one of the most important markets for FCA, and so production plants are concentrated here. But vehicles intended for Europe market may be assembled outside of this region, depending on company's strategy. In table 3.1 are reported the production plants for vehicles destined for EMEA market in 2018, excluding Maserati which will not be considered in further analysis and Joint Venture with other carmakers in APAC region to produce Fiat 124 Spider and Fiat Fullback, and in France to produce Fiat Talento.

New investment plan announced by the CEO Mike Manley establishes some changes starting from 2019 [15], like the new assembly lines in Melfi for the Jeep Compass alongside Fiat 500X and Jeep Renegade (new 2019 plug-in hybrid version included) and in Pomigliano d'Arco for the new Alfa Romeo C-SUV model, and the focus on electrification and hybrid versions for the current line-up.

Table 3.1 FCA's plants and vehicle produced for EMEA market (Source: FCA)

COUNTRY	PLANT	VEHICLES
Italy	Modena	Alfa Romeo 4C
	Cassino	Alfa Romeo Giulietta, Giulia, Stelvio
	Sevel Val di Sangro	Fiat Ducato
	Pomigliano d'Arco	Fiat Panda
	Melfi	Fiat 500X, Jeep Renegade
Serbia	Kragujevac	Fiat 500L
Turkey	Tofas	Fiat Tipo, Doblò, Fiorino
Poland	Tychy	Fiat 500, Lancia Ypsilon
Mexico	Toluca	Jeep Compass
USA	Toledo	Jeep Wrangler
	Jefferson	Jeep Grand Cherokee
	Belvidere	Jeep Cherokee

3.4 FCA compounds

A fundamental element for vehicles outbound shipping is needed to have an efficient distribution and to reach economy of scale in the transportation step: the compound. This is a big area where the vehicles are stored waiting for the transportation phase. There are three kind of compounds:

- Plant compound: vehicles are parked here after assembly process. It is located nearby the plant, but not in close proximity to avoid aggressive dust fall on cars;
- Port compound: it has loading and unloading functions for the maritime import and export, and it can be useful for transship purpose, in case a change of vessel is requested;
- Transit compound: it is an intermediate stock yard that allows a better distribution of vehicles.

All these typologies can work as Market Compound, in case the vehicles need only one last step of transportation. If the production takes place in the same country where the vehicles are intended to be sold, the plant compound will work as Market Compound. Otherwise, transit and port compounds will serve this purpose. In the compound will take place the change of responsibility between different roles, depending on which stage the vehicle is currently in. For example, at the plant compound the change of responsibility will regard plant/manufacturing division and Supply Chain Management's Vehicle Distribution, once the vehicle is ready to be shipped.

Each compound must respect specific requirements in terms of quality and safety, to guarantee that the vehicle maintains perfect conditions during its stay. It is crucial that the final customer receives the vehicle without any defect, to increase his trust and his satisfaction with the brand, with the aim to make him buy another FCA vehicle in the future.

Typically, the compound should use 65% of its capacity, to be able to react to overstock situations. Having a compound not fully saturated can be also convenient for a reduction in time of vehicle handling, and consequently an efficiency increase. This efficiency can be reached also following different rules in terms of space management. The compound is organized differently depending on the mean of transportation used. Generally, each macro-area is organized in rows that respect the First-In First-Out rule (FIFO).

In case a vehicle cannot be delivered, it will be stored in a particular area, and the compound provider must ensure some activities in order to preserve standards and quality, like detaching negative pole of the battery, raising windshield wipers, etc.

Italian compounds are distributed all over the country:

- 5 plant compounds: Mirafiori, Cassino, Sevel Val di Sangro, Pomigliano d'Arco, Melfi;
- 8 transit compounds: None, Rivalta, Fiumicino, Pontecagnano, Bologna, Piadena, Verona, Lonato;
- 11 port compounds: Savona, Genoa, Livorno, Civitavecchia, Salerno, Palermo, Catania, Gioia Tauro, Ortona, Ravenna, Monfalcone.

European compounds are summarized in Figure 3.2.

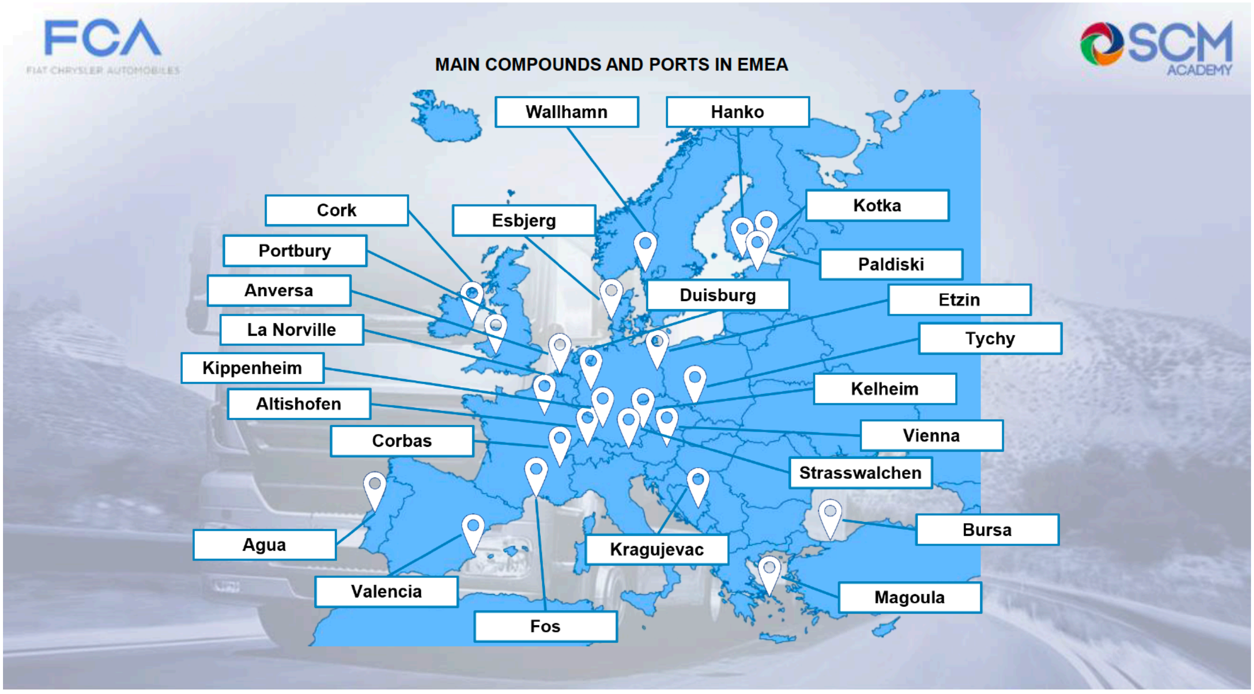


Figure 3.2 FCA's European compounds (Source: FCA SCM Academy)

3.5 Distribution process

After having introduced which are the nodes on the big network that FCA has all over the globe, main distribution processes will be introduced, how transportation works and which are the main routes used to deliver the vehicles.

3.5.1 Vehicles reception on compound

At the end of assembly line, the plant assigns the vehicle to the compound, printing and applying on it the Delivery Order Card (COC), which is the card that certifies the delivery.

On the COC are reported identification information about the vehicle: chassis model, Vehicle Identification Number (VIN), customer description, market description, transport zone description, point of arrival description.

At this point the vehicle and its delivery to the final customer are under Vehicle Distribution responsibility, and the logistic flow of the car has begun. The compound provider declares the Take in Charge (TKC) of the vehicle and certifies both physically and informatically the entrance of the car in the compound.

For those vehicles coming from other compounds and not from the production plant, instead of COC there will be the transport declaration (DDT), a document that describes and certifies what is transported.

Each compound must correctly declare every single vehicle that enters or leaves the compound.

3.5.2 Primary and Secondary transportation

The transportation of the vehicle from the production plant to the dealer is divided in two stages:

- Primary transportation: it covers the route from the production plant to the market compound;
- Secondary transportation: it covers the route from the market compound to the dealer.

It's important to clarify that primary transportation exist only if the vehicle is assembled in a plant outside the market which is destined to. Otherwise, the plant compound would work as a market compound, and so only a secondary transportation will take place.

For example, a Jeep Compass produced in Mexico and requested by an Italian dealer will have a primary leg of transportation from the plant to a port selected by FCA's Vehicle Distribution division, from which the secondary leg of transportation will start, to end at the dealer.

The primary transportation is managed by Vehicle Distribution EMEA, while it may vary for the secondary leg, depending on which is the destination market. In case of Italian market, Vehicle Distribution Italy manages the transport, while for foreign markets the responsibility shifts to the National Sales Company (NSC) and the transport is managed by logistics of the market considered.

Vehicle Distribution interfaces may be internal, like other divisions in the Supply Chain Management and other FCA departments, or external, like compound or transportation providers. The communication with these interfaces happens thanks to a strong IT network that includes OutBound Transportation (OBT, discussed later), COLORS and Web-Trimm.

3.5.3 Distribution flows

For vehicle shipment there are three main flows to consider:

- Physical flow: it is the actual flow of the vehicle from the production plant to the dealer and then the final customer. Complexity is variable due to many elements, like number of transit point in the route, means of transportation, transshipment ports. There is no unique route, it may change from a transportation to another, even if the starting point and the ending point are the same.
- Documental flow: it consists of all the documents necessary to guarantee vehicle transportation and manage customs clearance operations for import/export activities. These documents are: transportation documents (road freight), bill of lading (sea freight), commercial invoices, certificate of origin.

- Information flow: it consists of all IT systems necessary to have tracking data available onto proprietary software, to be able to know location and status of the delivery along the whole distribution chain. On the information systems, a series of initials are used to better understand at which stage the vehicle is:
    - ASS: "*Assignment*", it indicates when vehicle's responsibility shifts from manufacturing division to supply chain management;
    - ODS: "*Order of delivery*", it indicates that the vehicle can start its logistic flow, typically when there is a final customer who ordered this car;
    - TKC: "*Take in Charge*", it indicates the moment in which the transportation provider starts handling the vehicle;
    - MIL: "*Put on list*", it indicates that the vehicle will not be loaded until the list is full of cars to ship;
    - USC: "*Exit*", it indicates that the vehicle was shipped and so it has left the compound;
    - POD: "*Proof Of Delivery*", it indicates that the transportation provider has successfully delivered the vehicle to the dealer.

Figure 3.3 shows the combination of physical and information flow.

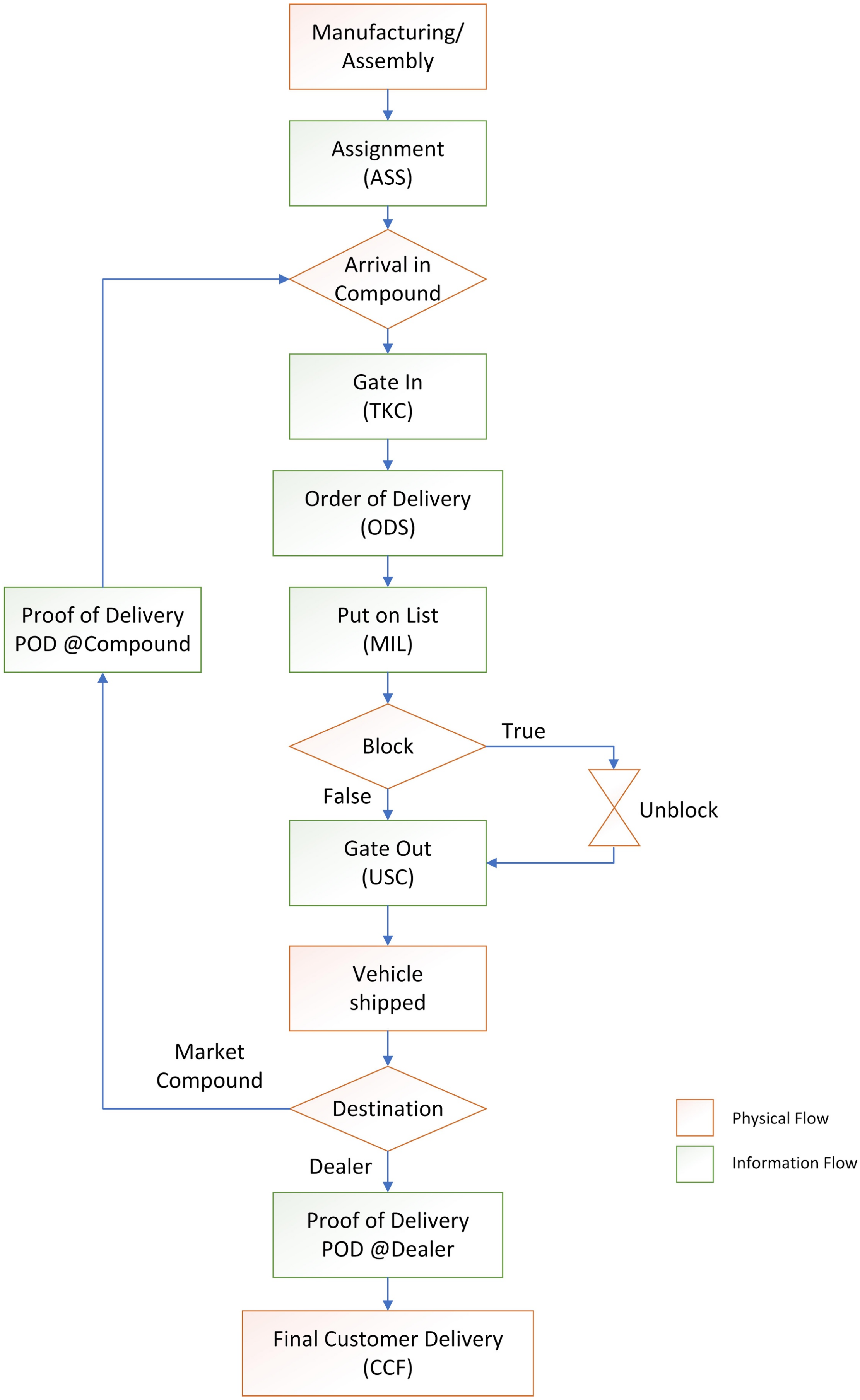


Figure 3.3 Physical and Information Flow Chart (Adapted from: FCA)

3.5.4 Transportation methods

There are various means of transport, depending on distance to cover and market of destination. The primary goal is to accomplish economies of scale. The most used are three: road, railway or ocean transportation.

Road transportation is based on car-carrying trailer and it is used for short-medium distances, mainly lower than 500km. Typically, this method is used on these routes: production plant to port compound, production plant to dealer, market compound to dealer, or in compound movements.

Compound provider prepares the loading list and sends it informatically to the transportation provider. Once the transporter has arrived, he will retire the transport documents, then he will load the vehicles on the car-carrying trailer. In case the vehicles are addressed to the dealer, the car transporter has to declare the POD to FCA.

Flexibility is the main advantage of road transportation, thanks to a large competition on the providers market, and also to the availability of many viable routes. Speed is another pro because this is the fastest method. Instead, disadvantages originate from the lower quantity of vehicles that can be loaded, making this method the most expensive. On average, each load of passenger cars is composed by 8 vehicles, depending on size and kind, while one load of Light Commercial Vehicle (LCV), like Fiat Ducato, will have fewer vehicles.

Road transport planning is weekly, at the end of week N for week N+1.

Regarding railway transportation, trains are used for continental (medium-long) distances, greater than 500km. The market shows a presence of a lower number of providers than the first method.

Differently from the road transportation, the railway transporter will load the car first and then he will retire the documents.

The main advantage is an economic convenience compared to road transport, thanks to a greater loading capacity of vehicles on the trains. On average, each train is composed by 18 coaches, that can be at single platform for LCVs, or double platform for passenger cars. However, disadvantages are numerous: network shows a significant inflexibility, compounds must be supported by suitable infrastructure. Furthermore, planning is strict, and transportation time needed is longer than car-carrying trailers.

Railway transport planning should happen at the beginning of week N for week N+1.

For long distances ocean transportation is the best choice, with the adoption of Roll-On/Roll-Off ships (RO/RO). The number of providers in this market is very small.

The vehicles are loaded on the internal decks of the ship. Thanks to a high number of vehicles storable on board, the cost of transportation is narrow. On average, on a RO/RO ship 6000 vehicles can be stored. Obviously, transportation lead-time is wide, and there is the necessity of ports with the right infrastructure.

Ocean transport planning has to be made during the last week of month M for month M+1.

Each of these methods should have an advanced planning to guarantee the right load capacity, to respect transportation lead-time, to evaluate backup solutions and to set specific plans for new vehicles launch.

3.5.5 Distribution network

Due to a large number of nodes (production plants, compounds, transit point, ports), the distribution network shows a high complexity. It must be noted that routes are not fixed, they can be changed in case of need or economic convenience. However, FCA tries to follow standard routes and methods for the transportation from the Italian plants to the first destination (Figure 3.3):

- Vehicles produced in Melfi and Pomigliano plants: train for Northern Italy and Germany, car-carrying trailer for Center and Southern Italy, ship for other markets through Salerno port;
- Vehicles produced in Cassino plant: car-carrying trailer for entire Italian market, ship through Salerno port for other European markets;
- Fiat Ducato produced in Sevel Val di Sangro plant: train for Austria, France, Germany and Poland, car- carrying trailer for Italian market, ship for other markets through Salerno port;

- Alfa Romeo 4C produced in Modena plant: car-carrying trailer for entire EMEA market, expect Turkey that receives vehicles through ships. This is due to a very low quantity of vehicles produced in Modena plant, that would not reach a sufficient load factor for trains.

Regarding foreign production plants (Figure 3.4 shows flow to Italian market):

- Vehicles produced in Bursa plant starts their flow from Tofas port: port of destinations for the Italian market are Monfalcone, Ravenna, Palermo, Salerno, Livorno and Savona. While for other European markets they transit from Salerno or Savona not being unloaded and continuing their journey to their destination;
- Vehicles produced in Kragujevac plant: railway or road for Austria, Germany, Poland and Switzerland, ship through Bar port for Italian market with destinations Monfalcone, Ravenna, Palermo, Salerno and Genoa, and for other markets transiting through Savona;
- Fiat Talento produced in Sandouville (France) plant: ship for all countries with access to the sea, while for other markets car-carrying trailers will be used;
- Vehicles produced in NAFTA plants: ocean transportation through Baltimore (for USA plants) or Veracruz (for Mexico plant) port, with destination Civitavecchia for Italian and Southern Europe markets, while for Northern Europe markets the destination will be Antwerp.
- Vehicles produced in APAC plants: ship with destination Livorno for Italian and Southern Europe markets, while for Northern Europe markets the destination will be Antwerp again.

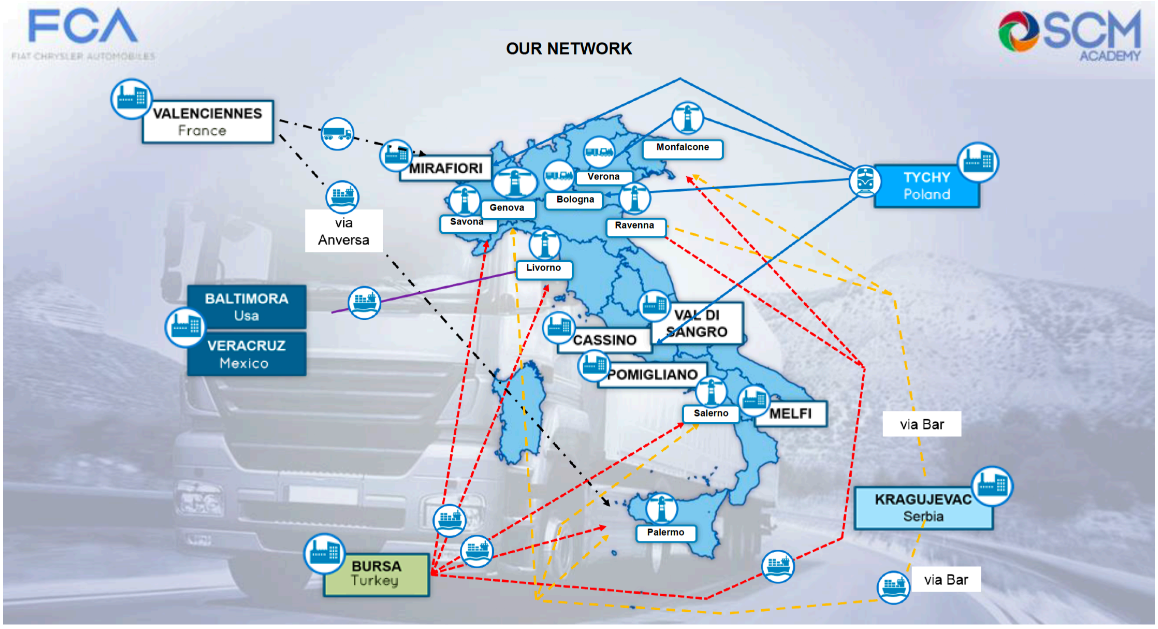


Figure 3.4 FCA's network for the Italian market (Source: FCA SCM Academy)

3.6 Pairing of the OCF

After a description of the OTD process, with particular attention on outbound logistics, a focus on the concept of OCF is necessary. The vehicles which the OCF is paired to are prioritized by FCA, because that means that these cars actually have final customers waiting for them, and the service level must be high enough to respect customer satisfaction. As said previously, OCF is declared by the dealer when a final customer has ordered his vehicle. The pairing of the OCF to the actual order can happen also in other stages of the logistic flow of the car, and not necessarily when the vehicle is yet to be produced. In fact, it can be paired when the car has already been manufactured or when the vehicle is at the dealer’s compound. An accurate categorization is needed to have a clear context. The situations in which the OCF can be paired are (Figure 3.5): Order, Dealer, On Route.

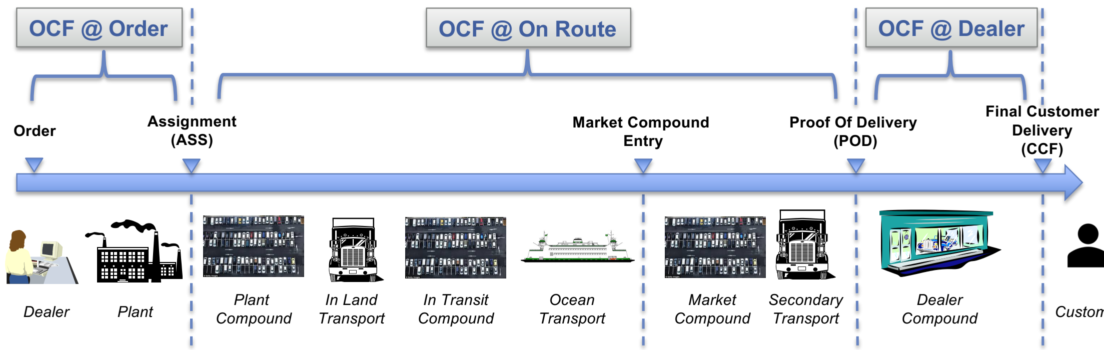


Figure 3.5 Representation of the categories: Order, On Route, Dealer (Source: FCA)

3.6.1 Order

The vehicles that belong in this first category are those that are still not in the manufacturing process, cars ordered by the customers with a specific configuration, so with the method discussed in the OTD process paragraph. The customer is in the showroom and plans together with the dealer how his vehicle has to be, and the car will be manufactured following his requests.

In this group are included also those vehicles that the dealer has ordered on his own forecasts but are not produced yet, the so-called Virtual Stock. Typically for these vehicles is still possible to make a configuration adjustment, if the manufacturing process is not so close in time.

3.6.2 Dealer

As said before, the dealer makes his own forecast and orders vehicles to respond faster to customer’s demand. FCA does not rush the delivery to the dealer due to giving the highest priority to OCF, and sometimes it’s the dealer himself that negotiate with FCA that the vehicle will stay on the market compound for a longer period, until he is ready to receive it. Once the POD is declared, the vehicle is at the dealer’s compound, and he can pair the OCF when a customer visits his showroom and he is interested in a particular vehicle that he has seen. So, the time frame in which the vehicle is finally delivered to the customer is very short.

3.6.3 On Route

In this category can be found vehicles that do not belong in the two categories that are the extremities: Order and Dealer. The vehicles that belong to this category are the ones that have left the manufacturing plant, and that are at least at the Assignment (ASS) stage. Therefore, the car is on the compound and the dealer can pair the OCF, so that FCA can accelerate the process of delivery. On Route category stretches till the POD has been declared by the transporter.

Chapter 4 – Delivery Process Improvement

This chapter will examine in depth the current status of visibility on FCA's side and on dealer's and customer's side, thanks to the systems and tools used. Furthermore, the project Delivery Process Improvement has been developed, focusing on customers' complaints, to assess the problems of communication with them and the dealer, to find weaknesses and potential solutions to increase customer expectation and data reliability.

4.1 Software and Tools

In these first paragraphs, two software used for visibility purposes will be introduced, one (OutBound Transportation – OBT) that FCA uses to keep track of the vehicles in their logistic flow and one (LINK) used by dealers to load orders to FCA and that they should use to be informed about the stage which the vehicle is in. Furthermore, two tools are introduced: Estimated Time of Arrival (ETA) and Available to Promise (ATP). These are strictly connected to the software, because for example ETA is calculated by and reported on OBT.

4.1.1 OutBound Transportation software – OBT

This software is used by Supply Chain Management for outbound purposes, mainly for compound management and to track the status of the vehicle on its way to the final customer.

The users that can access OBT system are various, for the sake of simplicity these four will be introduced: Supply Chain Management, compound management, carriers and market users.

There are many features available on this platform. Files sending and Online creation are the most relevant, because without them the entire system would be useless. The former allows the users to create files on their PC/server and then upload them on OBT to update information available on the system: carriers can upload the proof of delivery (POD), compound users can update operations like Gate-In (vehicle inbound from the manufacturing plant in the compound) and Gate-Out (vehicle outbound toward dealer or market compound), compound manager can upload files containing vehicle blocks or releases (for quality, dealer overstock and financial reasons). Users can upload manually through a direct data form entry the information for the categories previously discussed in case the carried volumes are not high enough to justify the creation of a file that would have been sent to FCA, with an increase in internal costs. This online creation can happen through PC/server or mobile app available for users.

Reports is another category of OBT platform, that contains important features regarding vehicle visibility. In this section, for enabled users, it is possible to view a series of reports regarding vehicle status, vehicle tracking, compound stock, etc. Vehicle status allows to have an overview of the information of the car, about destination, plant of production, customer code, billing date, and movement dates. From here a function can be accessed with all vehicle tracking information, to reconstruct history of the vehicle changes of position and to view future movements, with Expected Time of Arrival (Attachment 4.1).

In addition, compound manager and Supply Chain Management can check the stock in the compound, to have an overview typically of what is available, what is in the waiting list and what is under maintenance. Then, there is a feature that focuses on the carrier, where it is possible to check the performances of the carriers, what is in transit and what vehicles are assigned to each transportation provider. In the end, Reports has a function that enables compound workers to view the expected inbound and outbound volumes based on the distribution plan, either budgeted or forecasted, shown according to means of transport and grouped by month.

All the reports belonging to the features mentioned previously can be exported to run further analysis offline, for example about blocked vehicles, not shippable vehicles, the number of cars delivered to the dealer, and if the estimated time of arrival was respected, and create KPIs about all these compound and distribution processes.

4.1.2 LINK software

It is the FCA platform that dealers use to load orders. However, a large number of dealers do not use this software to issue offers and contracts with final customer, but Dealer Management System (DMS), which is integrated to LINK and other manufacturers software. DMS cater to the dealer's needs of finance, sales, inventory and administration.

LINK is the only tool that dealers can use to retrieve information about the status of the vehicle once the order has been loaded. In particular, the valuable information that this platform shows, when the dealer insert the VIN or the OCF code, are (Figure 4.1): Upload Date, Confirmation Date (the Friday of the week in which the car is expected to be manufactured), Estimated Time of Arrival (ETA), Assignment Date (the day in which the car has left the plant), Block (in case there are quality or financial problems), Last Compound (in order to be able to the last location of the vehicle), and billing data.

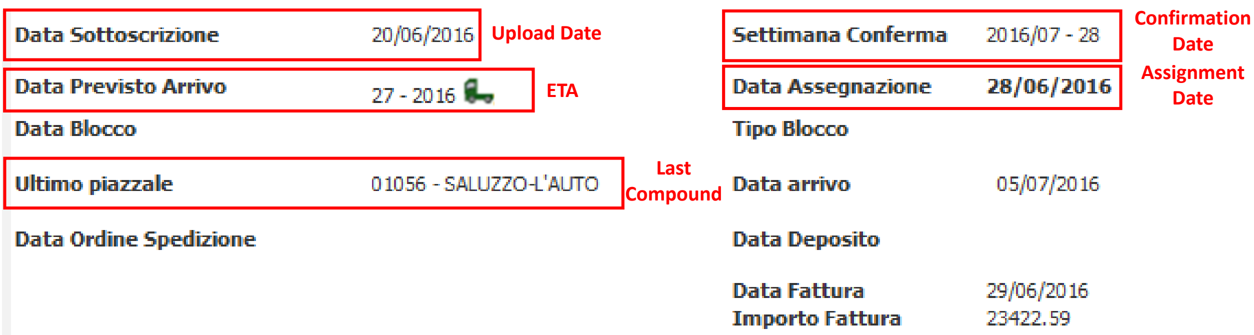


Figure 4.1 LINK's view for an Italian dealer (Source: FCA)

In order to know at which stage of the distribution flow the car is, LINK shows an icon, next to the ETA information (Figure 4.2). This icon can represent a plant, and that would mean the vehicle is still in the manufacturing process, or a truck, whose color depends on the stage of the distribution process.

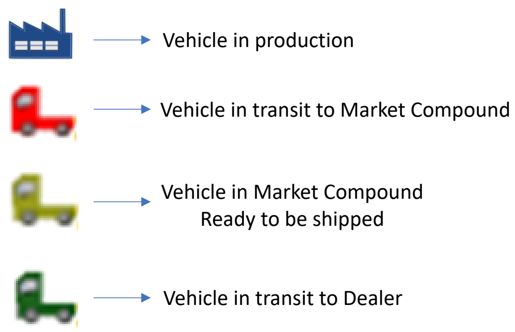


Figure 4.2 LINK - vehicle status representation (Source: FCA)

The dealer can retrieve the logistic status of the vehicle also through a series of codes set by FCA and assigned at the vehicle on its distribution flow, indicating at which stage the car is, without an exact indication of the actual location.

Between FCA and the final customers there is no direct contact, but it happens only through the dealer. Therefore, LINK and the dealers are fundamental pieces for the communication strategy of this company and for the visibility of their products to the final customers.

4.1.3 Estimated Time of Arrival – ETA

The Estimated Time of Arrival is the key information for vehicle visibility, representing the forecast of arrival of the car at the dealer's compound. For the actual delivery to the final customer, the dealer needs approximately 8-10 more days for preparation, financing finalization and registration to be done.

ETA is an exact date (e.g. April 2nd, 2019). It is calculated only when the order is matched with a Final Customer Order (OCF) by the dealer and production is scheduled, and it can be considered the first true "visibility-wise" information that customers can get, even though it is only available on the platform LINK for the dealer, who needs to communicate it. At the moment of the vehicle configuration and offer definition with the customer (so when the order is still not loaded), the dealer provides him a forecast estimation based on his experience and on *Available To Promise* (ATP) given by FCA (further description later).

ETA considers time for vehicle's production, primary and secondary distribution, and a safety buffer in order to cover many of the potential delays that can happen along the logistic flow, like blocks for quality or financial risk reasons (the most common) and variability in transportation due to bad weather conditions, traffic or transporter strikes.

The accuracy of the forecast improves as the vehicle travels through its distribution flow, because it is recalculated after every logistic gate.

OBT is in charge to calculate ETA, because it includes all the lead times set up for the computation. Information recorded on OBT can be exploited by Datamart and Colors, which are two relevant data-warehouses (DWH).

ETA is communicated to the dealer and becomes "Official" and can be updated with the "one only rule": Official ETA on LINK will be updated only if it worsens as compared to the previous provided, while it will remain the same even if there is an improvement. Reliability for the last ETA provided must be closer to 100%.

ETA is monitored: if the vehicle does not proceed in the distribution process, Operational ETA is recalculated and matched with official one, in order to identify and properly manage potentially critical vehicles.

Operational ETA, used by SCM divisions, can be divided in different indexes, depending at which stage of the distribution flow is in (Figure 4.3):

- ETA Dealer Prima is the forecast calculated when the order is confirmed and the production is scheduled;
- ETA Dealer Prima ASS is the forecast calculated when the vehicle has left the production plant and it has been assigned to the plant compound (Market compound in case in case vehicle's destination is in the same country);
- ETA Compound Ultima is the forecast calculated when the vehicle is shipped from plant compound toward market compound (this ETA is provided only if production is in a foreign country);
- ETA Dealer Ultima is the forecast calculated when the vehicle is shipped from the market compound toward the dealer.

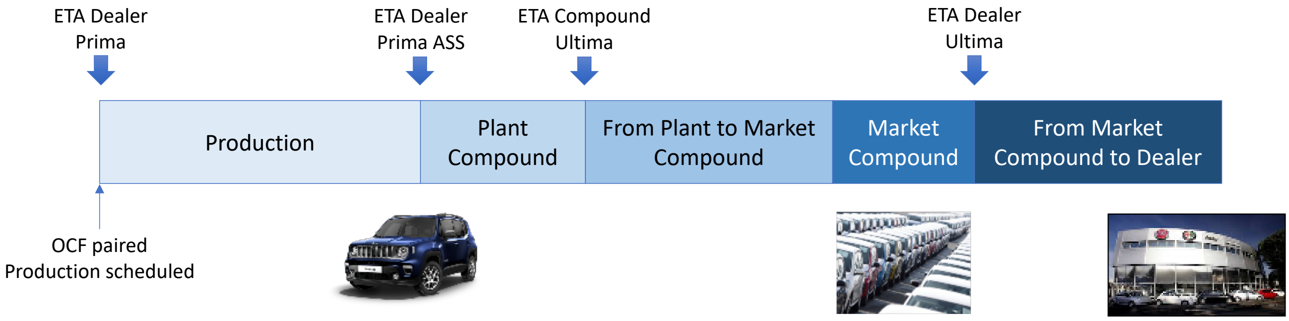


Figure 4.3 ETA development through distribution stages (Source: FCA)

ETA is an essential tool for FCA, because:

1. it allows to monitor the performances of compound and transportation providers in the distribution stages, and so it is fundamental that every actor in the supply chain communicates information with the highest reliability;
2. it is the only information that will be given to the dealer (and then eventually he communicates it to the final customer), so it has to be highly reliable.

It is important to clarify that being the fastest in vehicle delivery is not fundamental for FCA, but it’s necessary to be reliable and to respect the promised date to improve satisfaction and brand perception by the customer, in terms of distribution. A delivery delay would generate disappointment for the customer for sure, but also an anticipation, because he might not be economically ready, and so he will have to wait anyway.

One criticality of this index is that customers have not direct access to this information, but they have to ask to the dealer.

4.1.4 Available To Promise – ATP

The Available To Promise is a forecast of the time of arrival of the vehicle in weeks, but more approximate than ETA. In fact, ATP is calculated before ETA, when the car is still not ordered yet. It is provided to the dealers to give them an approximate duration of the production and distribution process, so they can be ready to communicate a reasonable date to the customer when they are with him/her and the order is getting configured (Figure 4.4).

Production lead time calculation will be based on order portfolio length and most relevant constraining features. A vehicle configured with a large number of optional elements will need a greater time to find his spot in the sequence of the Operational Planning (PO).

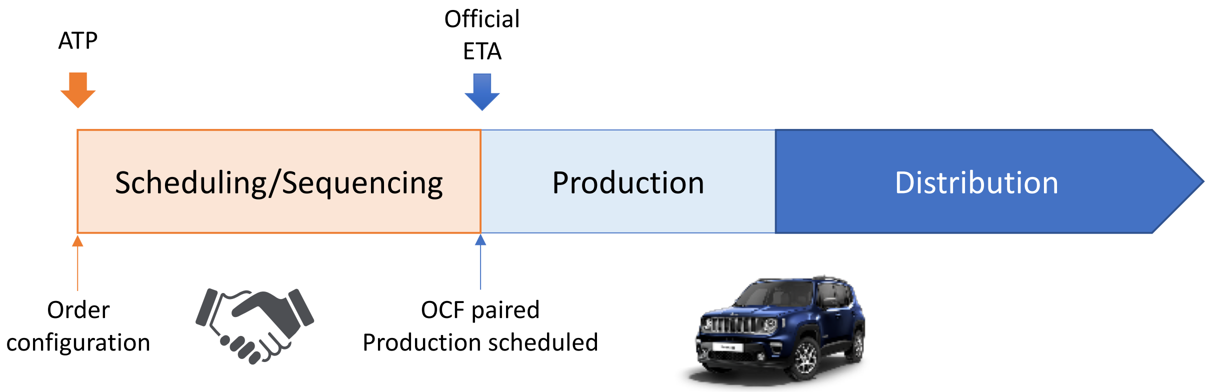


Figure 4.4 ATP & ETA (Source: FCA)

The actual configuration of ATP covers only production and primary transportation lead-times.

ATP is calculated weekly by SCM HQ, and then provided to the National Sales Company, which typically add the secondary transportation lead-time of their market, to then give it to the dealers.

ATP might be even more important than ETA, because it is the first approximate forecast that the customer will receive, and, together with car characteristics, in some cases it could be a pivotal factor in the vehicle and brand's choice.

For the analysis of the next paragraphs ATP will include also the lead times of the secondary leg of transportation.

4.2 Delivery Process Improvement – DPI

FCA, as all the other automotive companies, needs to pay attention to the customer satisfaction, and it does so through a series of surveys that can focus on different elements. The one which will be mentioned in this chapter is about Customer Experience (CX).

The Customer Experience survey is created by Customer Care division to detect customer satisfaction, dealer performances, delivery time compliance, Net Promoter Score (NPS) trends, etc. In particular, NPS measures customer experience and predicts business growth, with an answer on a scale 1-10 to the question: "How likely is that you would recommend this brand to a friend or colleague?" [16].

The CX survey is used primarily for purposes relevant to Customer Care unit, and not to Supply Chain Management division.

But through this survey some negative feedbacks regarding the supply chain have emerged, for what concerns delivery and visibility of the vehicle. So, a list of these critical vehicles was forwarded from Customer Care to Supply Chain Management, in order to understand which could be the roots of the problems.

In most of the cases, customers claim delivery delays or not having the possibility to track their vehicle while they're waiting.

The voice of the dealers is also important for FCA, as they complain that delivery date is not fully available and that competitors of the automotive industry pay more attention to visibility than FCA.

From these feedbacks that have been reported came the necessity to develop a project called Delivery Process Improvement (DPI), which consists in an analysis on the weaknesses and which might be the causes of the customers' complaints, and then think to feasible solutions, always keeping in mind the three main constraint of a project: time, cost, quality.

The main goal of this project is to improve the compliance of customer expectation, analyzing complaints to understand who's responsible for the delay or for the miscommunication, fixing information exchange processes between all of the actors in the supply chain (FCA, compound and transportation providers, dealers, customers), without altering necessarily physical distribution processes, which would be far more expensive.

A relevant factor for customer's claims and consequent requests, might be Amazon. As discussed in Chapter 1, Amazon main focus is the customer. It must be noted that Amazon, however, is not influenced by complex upstream processes, like inbound of materials and parts from all over the world, sequencing and then production, and so its focus can be totally centered on the customer. This company started a process of evolution of the customer expectations in terms of availability of products, short delivery time, and, more important regarding this particular project, visibility and reliability. This process can be called "the Amazon effect" [17]. Amazon has raised the bar of customer expectations for the automotive industry too, in terms of transparency and delivery reliability, with a seamless communication to the customers through: Available To Promise, Tracking and Proactive Delay Management (see Chapter 1, Paragraph 1.6).

FCA would like to close the gap with Amazon, and the Delivery Process Improvement project is a starting point, in order to achieve a proper setting of customer expectation.

This project was coordinated by SCM HQ, and it involved Customer Care, ICT, Quality and Legal divisions, with the help of National Sales Company of the five EMEA's Major Markets analyzed (Italy, France, Germany, Spain, UK) and a small sample of dealers selected for each market.

The analysis started from setting the proper standard lead times to compare to actual lead times, in order to cluster in categories and to detect responsibilities. The first markets analyzed were the Italian and the Spanish one, to have a first overview of the problems and to propose some preliminary solutions, to then expand to French, German and British one, to examine in depth the global situation of the five Major Markets and to elaborate final solutions to be presented to the Steering Committee, in order to get the approval. During the course of the analysis, few selected dealers were interviewed, to have an understanding of their practices regarding vehicle delivery and forecast calculation.

4.2.1 Sample matching

The Customer Experience survey includes a list of questions regarding expectations of the customer about the vehicle, and if they have been respected. This survey was submitted to more than 150.000 customers distributed in the five Major Markets that have purchased an FCA vehicle in the period December 2017 – September 2018, and only for cars which an OCF have been paired to. Of this total of 150.000 customers reached, the respondents were more than 100.000, already cleaned of the incorrectly completed surveys.

The vehicles considered in this analysis are those introduced in Table 3.1, so most of the American brands (not intended for the considered markets) and Maserati will not be mentioned.

Through the series of questions of the survey, there was only one relevant for this analysis: "Was your new vehicle delivered on the date originally promised by the dealer?". The sample was extracted from the customers that answered "NO" to this question, and it includes almost 3.000 critical cases. Thanks to the customer code and Vehicle Identification Number (VIN) included in the list forwarded from Customer Care division, it was possible to retrieve all the needed information, like dealer code, model, version and series, to pair those to the logistic events dates for each car, extracted from FCA databases.

The sample has been analyzed to cluster causes and understand possible improvements.

Having all the logistic events associated to each vehicle allows to divide them into the three categories, based on the sales model, discussed in Chapter 3, Paragraph 3.6: Order, On Route, Dealer. This classification is particularly helpful to identify who could have had responsibilities in the customer's complaint.

The information needed to group the critical cases are:

- Final Customer Order date (OCF): day in which the dealer pair the order to a vehicle already manufactured or yet to be produced;
- Assignment date (ASS): day in which the vehicle enters the plant compound. It just indicates that the manufacturing phase has ended;

- Proof Of Delivery date (POD): day in which the transportation provider declares that the vehicle has been delivered at the dealer's compound;
- Final Customer delivery date (CCF): day in which the dealer declares that the customer received his/her car.

OCF date is the information that allows to distinguish in which category the vehicle is included (Figure 4.5).

- Order: if the OCF has been paired before ASS has been declared;
- On Route: if the OCF has been paired between ASS and POD;
- Dealer: if the OCF has been paired after POD has been declared.

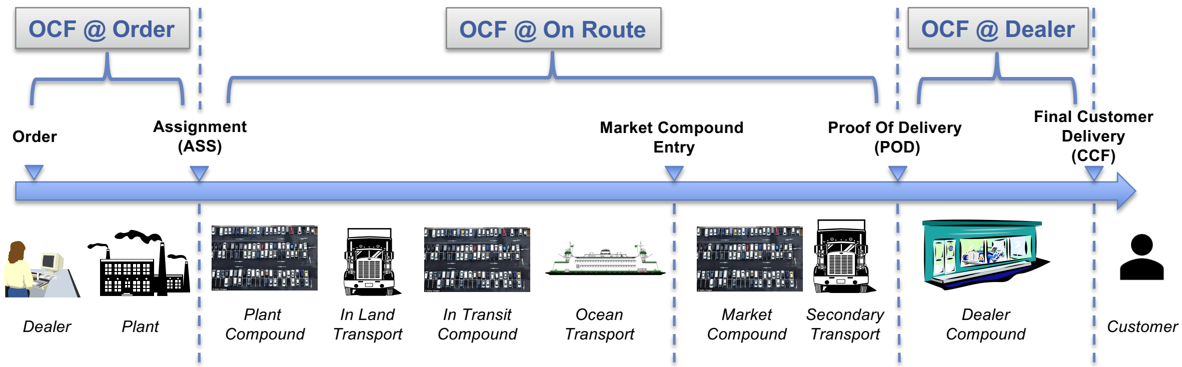


Figure 4.5 Categories of the critical cases (Source: FCA)

It must be noted that for the critical cases included in the Dealer category FCA has no responsibility for the delivery delay, because the car was already on the dealer's stock after he ordered it through his previous forecasts. So, in this case the dealer may have had problems, i.e. customer waiting time the day of the delivery, vehicle's registration or financing request.

For the Order category, since the car has not been yet produced, the manufacturing phase can influence delivery delays, and not just the distribution process.

This first categorization gives already an interesting perspective of the problem, because about 40% of the critical cases belongs to the Dealer category. So, it might seem that a huge part of the problem would be associated with the dealer and its practices.

Order has a similar weight, while On Route critical cases are almost the half of the Dealer category.

It's important to add that data on OCF pairing does not have 100% reliability. Indeed, it is possible that dealers declare an OCF whenever it's best for them, and not at the exact moment of a final customer order. So, the weight of the Dealer category might be lighter, and critical cases might migrate to the other two categories.

This miscommunication is already a problem that must be solved, because a perfect (or, even, reasonably good) data transmission is a step toward customer expectation improvement.

4.2.2 Promise and Delivery

To better investigate possible weakness points it is necessary to go deeper in the analysis and to distinguish other sub-categories for the critical cases. All of the following numerical analysis have the goal to give a general perspective of the problems, and not to focus on the reasons why every single vehicle delivery has received a complaint.

Now the focus will be on the comparison between standard and actual lead-times of the distribution process. The two categories that came out from this examination are:

- Promise: if the delivery process has been performed in line with overall lead times. No objective causes of complaint could have been found from production or distribution point of view.
- Delivery: if the delivery process has NOT been performed in line with overall lead times. There may have been problems in the manufacturing or distribution processes, that typically do not happen.

For what concerns the Delivery category, it can be further split in:

- Delivery FCA: if the actual distribution time exceeded standard lead times considered;
- Delivery Dealer: if the dealer exceeded the standard times attributed to him for the delivery.

Regarding vehicles included in the Promise category, it was not created the proper expectation for the customer, because dealers may have promised a delivery date too close in time, compared to what FCA was actually able to offer. It is possible that dealers did not pay attention to the information given to them (ATP), but they give a forecast based only on his experience or not too far away in time to avoid the customer leaving without purchasing the vehicle.

Promise is the largest category overall (Figure 4.6), including more than a half of the critical cases, while Delivery FCA and Delivery Dealer have almost the same size.

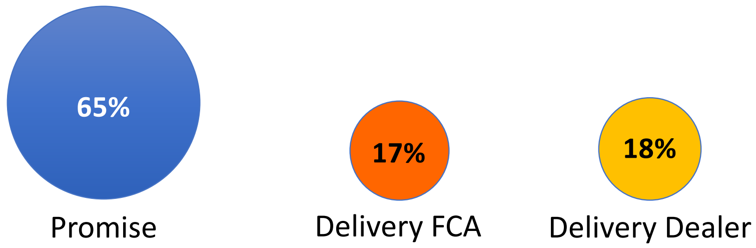


Figure 4.6 Global Overview: Categories' sizes (Source: FCA)

So, this means that the solutions must address especially the Promise category, and the focus needs to be on improving the communication that the dealer has with the customer, giving him better tools to increase his efficiency (discussed later). Delivery FCA and Delivery Dealer will always have a variability that could cause flaws, so addressing strongly these categories might not generate the same improvements that investing in solutions for Promise could have. A strong impact on Promise category might generate a considerable increase in customer expectation.

To have an overview of the problems, these three categories are applied to Order, On Route and Dealer.

4.2.3 Dealer – Promise and Delivery

For this sales model, the Delivery FCA category will not be mentioned, because the vehicle is already on the dealer's compound, and so FCA will not have any responsibility in the complaint.

Then, the feasible options for the critical cases are Promise and Delivery Dealer. To find out what vehicles had to be included in which category, the actual delivery time used was the interval OCF – CCF, since the vehicle has already been delivered and the POD has been already declared. It was set a threshold of 10 days as a standard time in which the dealer had to close the delivery.

To recap, the critical cases are included in these categories:

- Promise: if the interval OCF – CCF $\leq$ Dealer Standard Lead Time (= 10 days);
- Delivery Dealer: if the interval OCF – CCF $>$ Dealer Standard Lead Time (= 10 days).

In terms of quantity of critical cases, Promise is way more significant than Delivery Dealer (Figure 4.7).

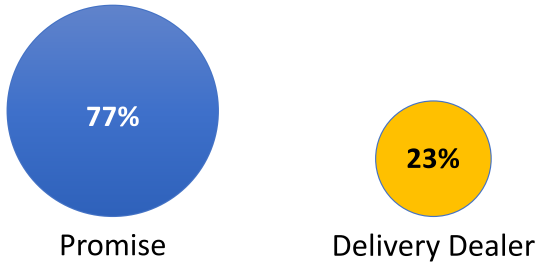


Figure 4.7 Dealer: Categories' sizes (Source: FCA)

But, it must be noted that, since it could happen that dealers declare OCFs whenever it's more convenient for them, this category is oversized, and a lot of OCFs included in here should be moved in the other two (Order and On Route), with a consequent decrease of the Promise class. The Delivery Dealer is hard to remove, because a part of this problem is intrinsic, and there will always be, due to, for example, financing finalization processes and registration of the vehicle.

For the cases included in Delivery Dealer a further analysis was made, regarding how many days of delay were reached for deliveries of vehicles. Figure 4.8 shows the cumulative curve of vehicles delivered later than the standard 10 days considered, so with an interval OCF – CCF > 10 days. The days of delay are represented on the X-axis, i.e. the difference between the range OCF – CCF and the dealer standard lead time, while on the Y-axis the cumulative percentage of delayed delivery cases. As it can be seen 85-90% of the complaints vehicles have been delivered in a window of time of almost 30 days over the standard lead times, and it is reasonable to consider the remaining 10-15% as a tail that includes vehicles for which the dealer had troubles in information exchange with FCA due to his inattention or platform malfunction, and critical cases with not solvable problems. Delivering a car already in the dealer's compound in more than 40 days (10 days of standard time + 30 days) is highly unacceptable, and it may be only due to these mentioned problems.

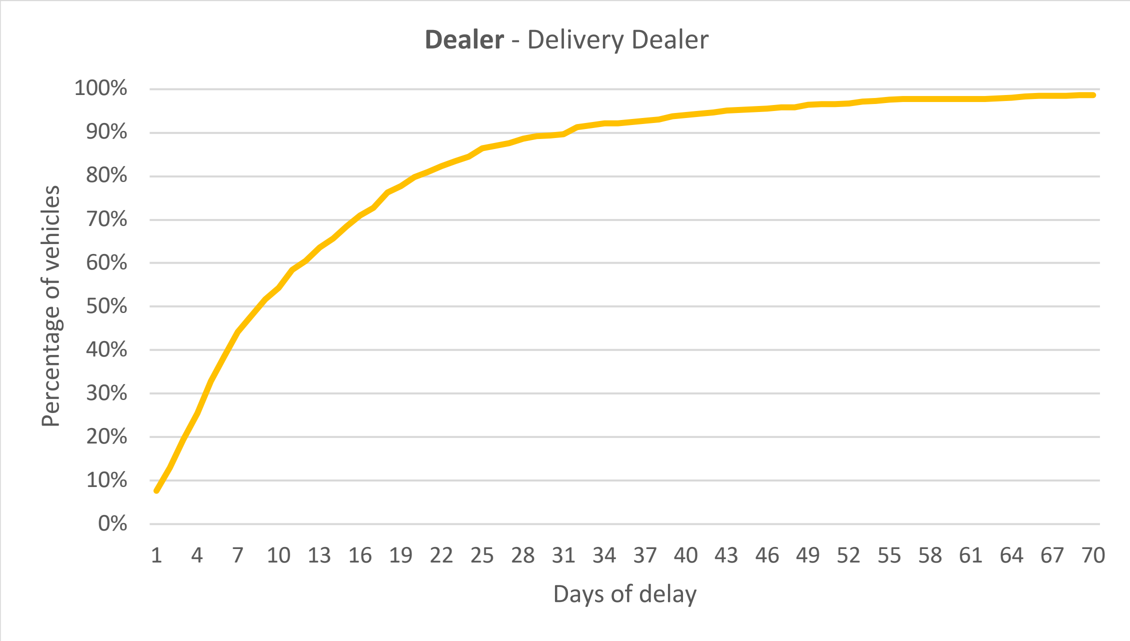


Figure 4.8 Dealer Category: Delivery Dealer - Cumulative percentage of vehicles per days of delay (Source: FCA)

4.2.4 On Route – Promise and Delivery

For the On Route category the production process does not affect delivery delays, because the vehicle has already left the manufacturing plant.

The starting point to distinguish the three categories is to identify the Promise one. To do so, the interval OCF – CCF has been compared to the standard times given by the ATP (only transportation lead times) retrieved from FCA databases, plus 10 days of dealer standard lead time. All vehicles that are not part of this group were necessarily included in one of the other two.

The ranges to be compared to the standard lead-times are OCF – POD for Delivery FCA and POD – CCF for Delivery Dealer. The range OCF – POD was compared to the transportation lead times resulting from ATP, while POD – CCF was compared to the threshold of 10 days previously set.

It must be noted that it is possible to have vehicles that exceed both Delivery FCA and Delivery Dealer standard lead times: in this case FCA will take in charge the responsibility, because its delay might have caused problem to the dealer, who had to deliver the car out of the standard lead time set. So, in this case the vehicle will result in the category Delivery FCA.

To recap, the critical cases are included in these categories (Figure 4.9):

- Promise: if the interval OCF – CCF ≤ Primary Transportation + Secondary Transportation + Dealer Standard Lead Time;
- Delivery FCA: if the interval OCF – POD > ATP (= Primary Transportation + Secondary Transportation);
- Delivery Dealer: if the interval POD – CCF > Dealer Standard Lead Time (= 10 days).

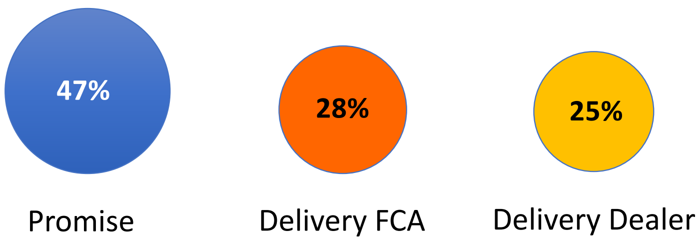


Figure 4.9 On Route: Categories' sizes (Source: FCA)

Numbers are almost in line with results from other categories. Promise is still the dominant class, confirming the existence of a problem on the creation of customer expectation. Since the quantity of critical cases is almost the half compared to Dealer and Order, the Delivery FCA regards a small number of vehicles. Distribution includes variability that is difficult to exclude completely from the process, and inevitably there will be vehicles delivered with small delays.

As done previously, an analysis of the distribution of critical cases per days of delay has been made. Regarding the Delivery FCA class (Figure 4.10), almost 80% of the vehicles considered in delay have been delivered within 14 days (circa) over the standard times set (ATP = Primary Transportation + Secondary Transportation). Considering that, most of the times, the vehicles included in this investigation arrive from a foreign country, or even another continent, an additional buffer might be introduced, in order to reduce the critical cases. Introducing a buffer of 7 days in the calculation is enough to reduce the cases of 50%.

For Delivery Dealer class (Figure 4.11) the same reasoning of the Dealer category can be applied. Indeed, the long tail will certainly include information exchange problems or critical cases with not solvable issues.

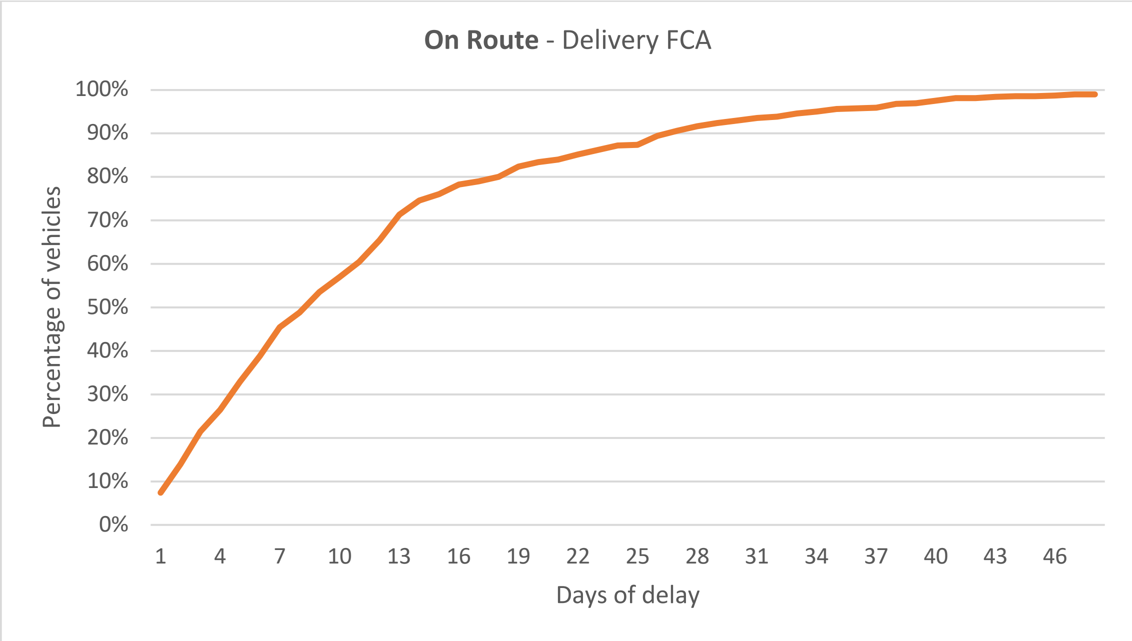


Figure 4.10 On Route Category: Delivery FCA - Cumulative percentage of vehicles per days of delay (Source: FCA)

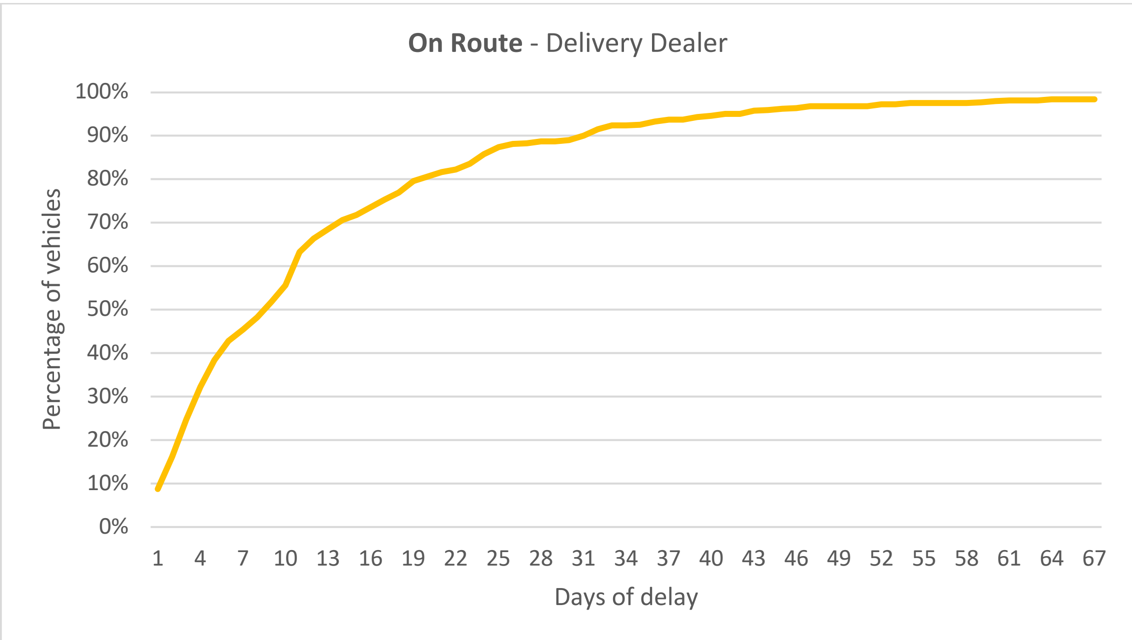


Figure 4.11 On Route Category: Delivery Dealer – Cumulative percentage of vehicles per days of delay (Source: FCA)

4.2.5 Order – Promise and Delivery

This is the most articulated category, because the manufacturing process may influence the potential delivery delays, since the OCF is paired when the vehicle has not been produced yet.

The starting point is the same as the On Route category: to identify which vehicles are included in Promise, comparing the interval OCF – CCF to FCA's standard lead times set.

For the Delivery FCA category the comparison was made between the range OCF – POD and the ATP (that now includes also the production time), while for Delivery Dealer it was compared the range POD – CCF with the dealer standard time of 10 days.

In the Order category might also happen that a vehicle results in both these two classes, and, as it has been done before, FCA will take in charge the responsibility for the delay, and the critical cases are attributed only to Delivery FCA.

To recap, the critical cases are included in these categories (Figure 4.12):

- Promise: if the interval OCF – CCF $\leq$ Production Lead Time + Primary Transportation + Secondary Transportation + Dealer Standard Lead Time;
- Delivery FCA: if the interval OCF – POD $>$ ATP (= Production Lead Time + Primary Transportation + Secondary Transportation);
- Delivery Dealer: if the interval POD – CCF $>$ Dealer Standard Lead Time (= 10 days).

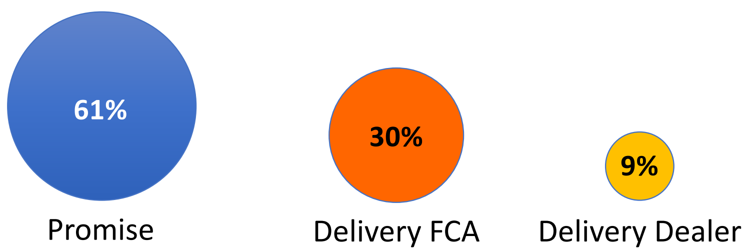


Figure 4.12 Order: Categories' sizes (Source: FCA)

In this case Delivery FCA includes a lot of cases in which there was a combination of responsibilities with the dealer, that shows a small number of vehicles indeed.

Since production process is also included in the calculation, it might be useful to investigate beyond. Indeed, if a vehicle is included in the Delivery FCA class, it might have had problems in the manufacturing stage, in the distribution process, or in both. To check which part of the process is responsible for the delay, more comparisons have to be made with standard ATP split in production and distribution. In particular the production lead time will be compared to the range OCF – ASS, and the distribution lead time with the range ASS – POD.

For this reason, Delivery FCA has been split in three additional categories (Figure 4.13):

- Production: if the interval OCF – ASS > Production Lead Time;
- Distribution: if the interval ASS – POD > Primary Transportation + Secondary Transportation;
- Production & Distribution: if both previous conditions are true.

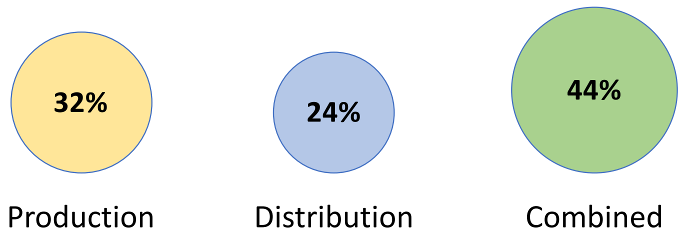


Figure 4.13 Delivery FCA: split categories' sizes (Source: FCA)

The influence of the production is relevant, since it occurred to three quarter (32% + 44%) of the vehicles included in Delivery FCA category. This can be due to the standard times used, that do not include additional time for vehicles with optional configuration. Production scheduling for basic vehicles with no optional configuration is easier. Indeed, a customer that has specific requests for his car will have to wait more for it to be produced, but in this analysis the data used were an approximation of the lead time needed to manufacture a vehicle with standard configuration. These production delays might be the causes of the high result of 44% of vehicles with distribution issues too, because delivery might have been rescheduled causing troubles in respecting standard times.

The analysis of the distribution of the critical cases belonging to Delivery FCA (Figure 4.14) per days of delay shows that 80% of the vehicles are delivered within a month after the considered standard times (ATP = Production Lead Time + Primary Transportation + Secondary Transportation). But, since the lead times considered are wider, a larger buffer might be introduced to reduce strongly the number of critical cases. In particular, a reasonable buffer of 14 days is enough to reduce of almost 40% the cases.

For what concerns Delivery Dealer (Figure 4.15), the tail is longer in this case. So, the observed problems are more solid and they have to be further investigated.

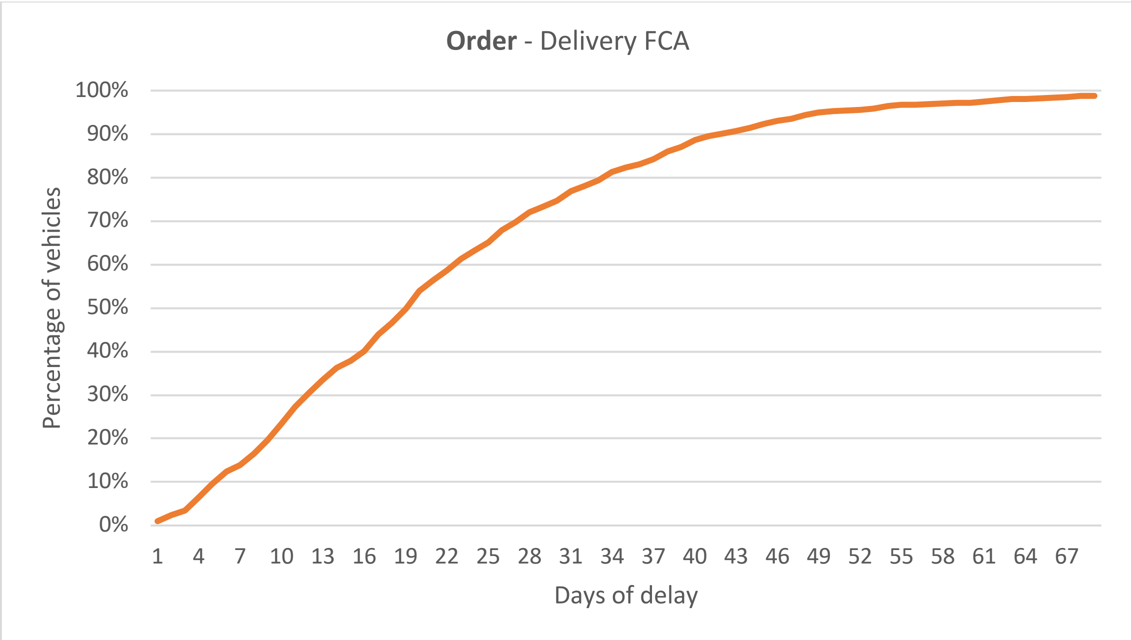


Figure 4.14 Order Category: Delivery Dealer - Cumulative percentage of vehicles per days of delay (Source: FCA)

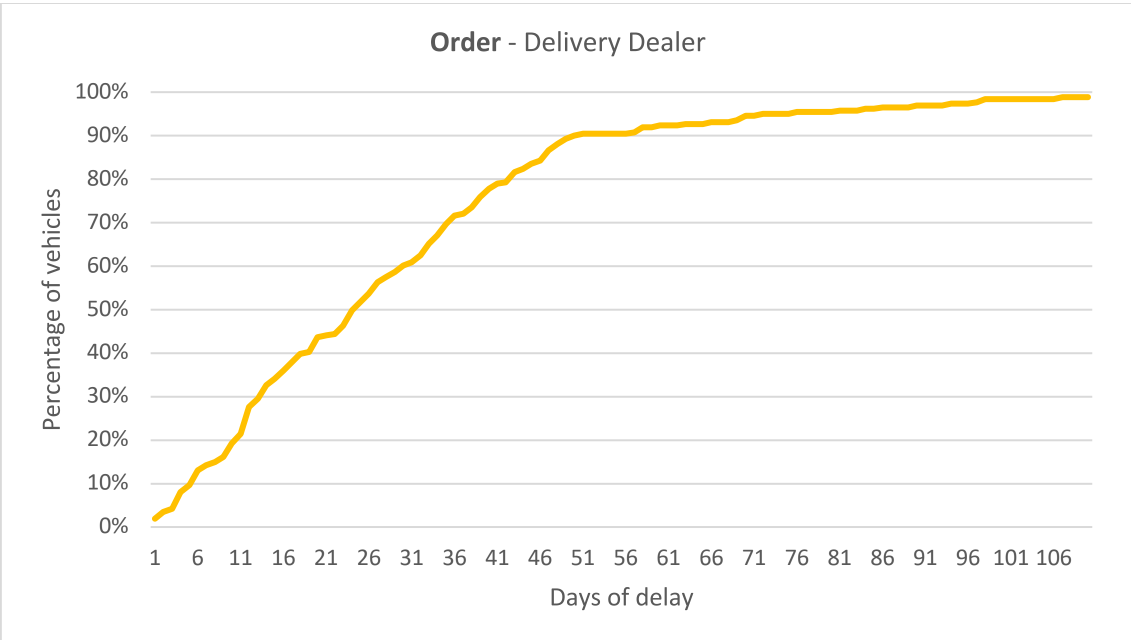


Figure 4.15 Order Category: Delivery Dealer - Cumulative percentage of vehicles per days of delay (Source: FCA)

4.2.6 Conclusions on Promise/Delivery

As seen, Promise is the largest category. So, the problem is a failed creation of the proper customer expectation.

Investing on solutions that can reduce the Promise category is more profitable than a heavy investment on the other two categories, because unexpected events are inevitable and there will always be a percentage of complaints in these fields.

Therefore, the Promise is the category to attack more decisively, to have a bigger impact on performances that regard customer expectation (further discussion later). A hard work has to be made in cooperation with the dealers that are fundamental for setting customer expectation accurately.

The survey submitted to the customers also has to be improved, because as of right now it may include complaints about delivery delays, when, actually, the customer complains about a longer waiting time at the dealer showroom the day of the pick-up. By deleting this source of error future analysis can have a more reliable database to work on.

4.2.7 Promised Delivery Date – PDD

Leaving aside the Promise and Delivery analysis, it is now necessary to check if the dealer is communicating information to the customer and to FCA properly.

For every OCF loaded on LINK, the dealer must insert the Promised Delivery Date (PDD), that is the supposed date in which the vehicle will be delivered to the final customer. For foreign markets this input is mandatory, while at the moment it is not for Italy. This information has to be in line with what is written on *Patto Chiaro*, which is the contract between dealer and customer, that has the goal to make the purchasing conditions transparent.

The critical cases belonging to the dealer category will not be considered, because, as said previously, the vehicle is already on dealer's compound, and so FCA has no responsibility.

First of all, data displays that, despite being mandatory, not all OCFs from foreign countries show a PDD associated.

Thereafter, not all the remaining PDDs are reliable. The PDDs that were set before the date of OCF pairing were rejected. Furthermore, PDDs were rejected also if they were too close in time to the OCF pairing date, in particular for the two remaining categories:

- Order: if the range OCF – PDD < 30 days;
- On Route: if the range OCF – PDD < 15 days.

After having rejected this PDDs, only 52% of the total considered OCF, which FCA could have responsibility on (Order and On Route), are reasonable. This result highlights the inefficiency in the communication that dealers have with FCA. The dealer must be encouraged to use the PDD tool properly, in order to make FCA able to be informed of what the customer has been told and to have reliable data in case a new analysis has to be made. The solutions that have to be found for this topic are in line with those for the Promise category, since the problem is almost the same: a wrong (or missing) communication cannot create the proper expectation in the customers.

4.2.8 Dealer Interview

To investigate the practices and to understand the critical issues, an interview to a small sample of dealers for each of the five examined markets was necessary. Since the Promise category is by far the largest one, the submitted questions were focused on this issue and how they build customer expectation. So, they were asked on what basis they define the PDD and if they use the tools made available by FCA (ATP), if the PDD given to the customer is the same declared to FCA, how they check the vehicle logistic status and what are the main information related to tracking they would need, how much time they need to deliver the car once it is on their compound and various others related to this topic.

The answers given by the dealers were the starting point to develop solutions to solve the communication problems.

It has been highlighted that:

- Italian dealers do not use ATP because the Sales Director gives the PDD based on his experience, and in his calculation he counts 10 days for the order to be issued and 10 days for the delivery finalization to the customer. Foreign dealers believe ATP is useful but needs an adjustment.

- All dealers declared that there is no tracking of the vehicle, they would like to know which gate has reached on the distribution process, and they would like ETA to be updated after every logistic event (as of right now ETA is only updated if it worsens).
- All dealers stated that being proactively warned in case of delay of the vehicle would be useful, and that (for this small sample) only Light Commercial Vehicles (LCVs) delays are critical.
- The Promised Delivery Date communicated to FCA is the same written on *Patto Chiaro*.

Having these interviews with the dealers was fundamental also to have a perspective of the competitors' practice, because in some cases it was highlighted that Audi and Opel offer their customer the possibility to download an app, from which they can track the status of their vehicle. And furthermore, they can purchase additional services while the car is still in the production process or in the distribution phase.

4.3 Solution Proposal

Certainly, the actual communication condition between FCA and the dealers has to be rearranged.

The *As-Is* situation shows multiple streams of data transferred from FCA operations to the dealers (and through them eventually to the customers), like Available To Promise, confirmation date of production, Estimated Time of Arrival, status, production date, blocks, etc., while there should be only one stream traveling in the opposite way with the Promised Delivery Date, but often this information is not reliable or missing. The overall approach is regenerative, for example every week ATP is published but with no alert, so the dealer might not pay attention to the update (in case he actually uses it for his forecasts). Dealer can only find out of the delay if he frequently checks his database, otherwise FCA will not directly alert it to him.

The *As-Is* situation can be summarized in:

- poor data visibility for central cross functional governance and information disconnection toward dealer (and consequently final customers);
- a complex overall operational process, that is properly managed but with poor communication;
- when the delay has occurred, there is a reactive approach with "firefighting" activities, and not a proactive approach that should try to avoid it in the first place;
- intensive use of basic communication tools to share data (emails, phone calls, excel files, etc.).

Instead, the intention for the *To-Be* situation is to have a leaner communication but more robust, in both directions (Figure 4.16).

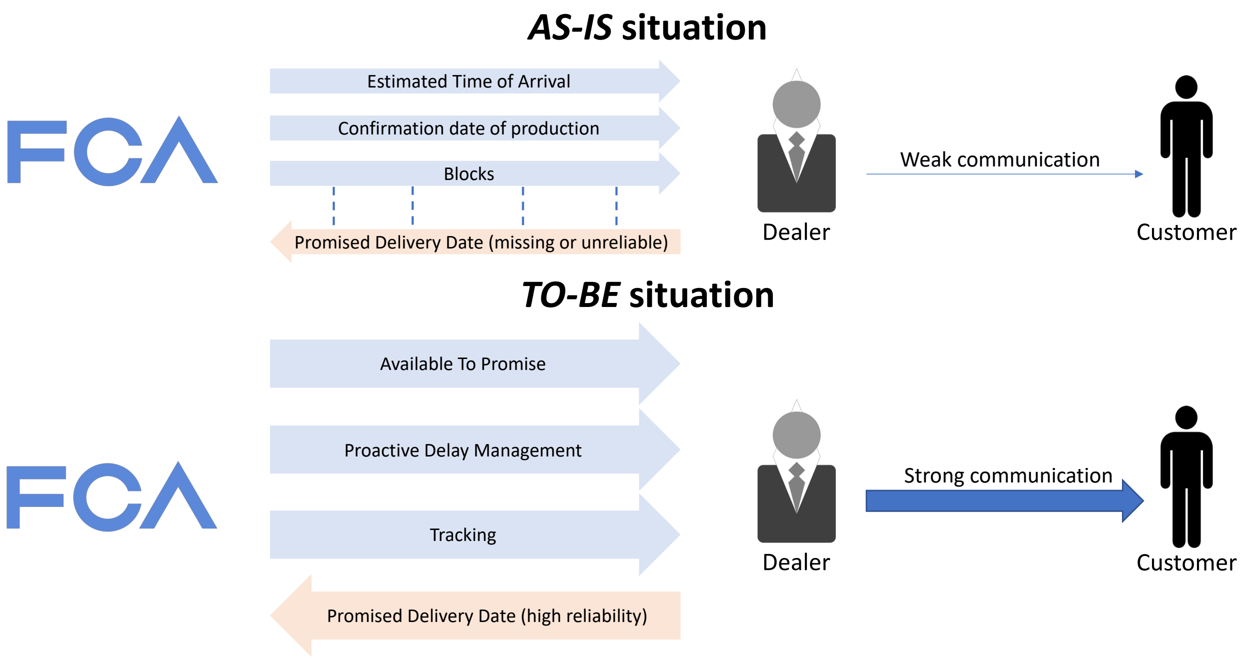


Figure 4.16 Comparison between overall AS-IS *and* TO-BE *situations (Source: FCA)*

A new process and ICT solution is currently under evaluation, and it will address mainly the observed Promise problems, paying also attention to aspects of Delivery FCA and Delivery Dealer. The main elements for new solutions to keep in mind are:

- Implementation of a proactive approach, in order to identify in advance criticalities;
- Immediate communication in case of delay to the dealer;

- Training to dealers to increase the use of LINK to issue *Patto Chiaro* and related PDDs;
- Concept of the control tower: one stop shop enterprise that ensures visibility of the process end-to-end;
- Creation of KPIs, with the goal of measuring performance for the various actors in the supply chain.

The solutions will be identified mainly for Order and On Route categories, since FCA has zero (or limited) responsibility in Dealer one.
A monthly survey will be submitted to the dealers once the solutions are in place, to investigate how and if the tools given to them are functional and useful to their work, and to measure their satisfaction working with those. This will allow FCA to have a first feedback in a short period of time on the solutions that have been developed, since the improvement on final customers will take more time to be perceived.

4.3.1 Proposals for Promise category

The main solutions for this category regard the simplification and strengthening of the ATP information, developed differently for vehicle belonging to the classes Order and On Route (Figure 4.17).

All of the next proposed solutions have been evaluated and proposed by SCM's subdivision Process&Methods in cooperation with Demand&Production Planning, also after having taken inspiration from competitors' best practices, to make the dealer able to communicate properly with customers, giving him the right information to set expectations appropriately.

Regarding the Order category, it has already been developed a new format of ATP, that dealers can print and bring with them while they are configuring the car together with their customers. This leaflet shows basic information about delivery time in days, when the car is going to be available approximately, production notes, i.e. vehicle with optional configurations will require more time to be produced, and available stock for the specific market (Attachment 4.2). This solution has been conceived to make the dealer able to have a smart and clean tool always with himself, replacing the old method of sending him a huge quantity of data that probably would have been unnoticed. It will be released weekly to the NSCs, which then will take charge of the responsibility to spread it to the dealers belonging to their markets. This ATP will be called ATPL, where "L" stands for Leaflet.

For what concerns the On Route class, on ATP will be applied a funnel logic, i.e. while the vehicle travel through its distribution flow, the ATP will get more and more accurate after every gate it goes through. Indeed, depending on which stage the vehicle is, the ATP includes a buffer higher (production yet to begin or just finished) or lower (car close to destination). Having a funnel approach applied to ATP will increase the reliability of the delivery date that the dealer will provide, as the vehicle gets closer to final destination. This ATP will be called ATPP, where "P" means Provisional.

These implementations have the goal to increase the number of PDDs submitted via LINK, increasing also their reliability. This can be possible making mandatory the use of LINK in Italy and through a training to dealers, making them understand the relevance of having reliable PDDs: it is a win-win situation for both the parties in terms of customer satisfaction. The expected improvements due to a better use of the Promised Delivery Date will be valid also for the Delivery Dealer category.

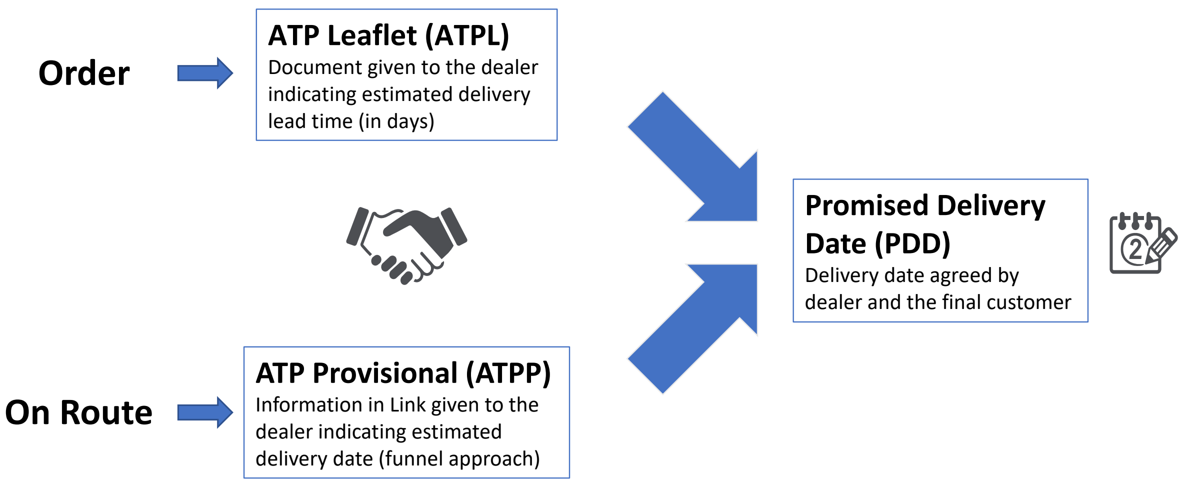


Figure 4.17 Main proposed solutions for Promise category (Source: FCA)

4.3.2 Proposals for Delivery category

The following proposals for Delivery category have been evaluated by Process&Methods division, based on the results of the previous analysis and the interview with the dealer, that highlighted some elements to focus on, and those will regard various topics: ETA and its calculation, a system to proactively manage the delays, and a tracking tool for the dealers.

The ETA for both categories Order and On Route will be based on the new formats of ATP (ATPP/ATPL). For vehicles still not assigned (ASS), the scheduling activity is performed as usual introducing in addition the same buffer of the ATPP (in this case the higher buffer, because the vehicle has still not been manufactured), and the dealer will see the ETA corresponding to the week of production after the OCF is paired and the order is scheduled for production. Instead, for vehicles that have been assigned, the ATPP will become the ETA, and the same approach of funneling will be applied (Figure 4.18). Introducing this approach will be useful both for FCA and the dealer, to respect checkpoints and to increase reliability of forecast while the vehicle is travelling.

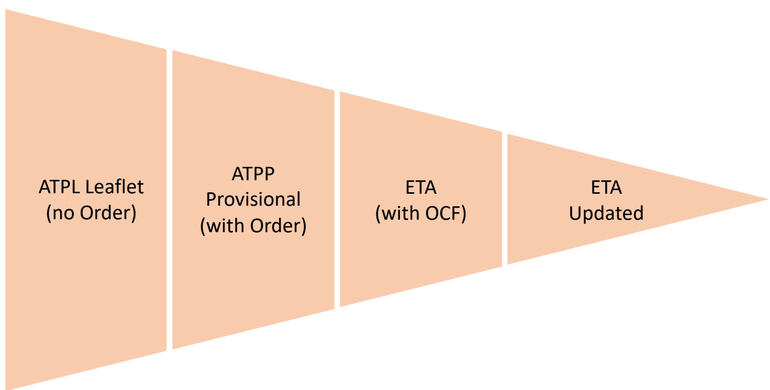


Figure 4.18 ETA funnel approach (Source: FCA)

The Proactive Delay Management is a system that needs to be introduced to make the communication of delay or blocks conditions with dealers easier and faster. The interface has to put in evidence clearly potential occurring delays, highlighting the critical OCFs and alerting automatically the dealer, with an eventual re-plan of the delivery.

In addition to this system, a tracking widget will be made available for dealers in the order details page on LINK, where they will be able to see clearly the milestones and latest gate the vehicle has reached (Figure 4.19). As said before, the interface has to be clear and lean, to reduce the possibilities of the dealer to communicate a wrong information to the final customers.

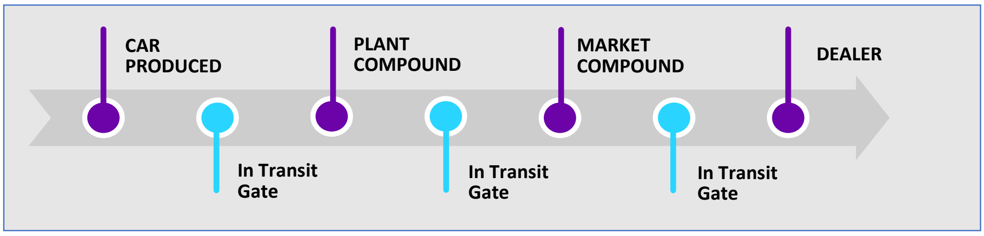


Figure 4.19 Tracking tool soon available for dealers (Source: FCA)

4.4 Innovative technologies

At this point in time, when the argument of new innovative technologies is introduced, it is impossible to leave aside the notion of *Industry 4.0*. This phenomenon encompasses the development and integration of innovative information and communication technologies into the industry. The main goal is to foster the intelligent networking of products and processes along the value chain, thus allowing it to use more efficiently the organizational processes, into the creation of goods and services to enhance customer benefit offering them new products and services (Barreto et al., 2017). The vision of Industry 4.0 emphasizes the global networks of machines in a smart factory setting capable of autonomously exchanging information and controlling each other. Industry 4.0 promotes the use, among others, of *Big Data*, *Internet of Things* (IoT) and *Artificial Intelligence* (AI) (Tjahjono et al., 2017).

IoT technology is particularly interesting for supply chain environment, because it allows the monitoring of travelling goods through a series of connected sensors on assets and the vehicles which move them, to provide on-demand location and time data. With this real time reliable data collection better decisions can be made, as well as better subsequent analysis. This generates a huge amount of data, that ordinary devices are not capable to elaborate, and for this reason Big Data enabled machines are required.

Barreto and other authors affirm that supply chain is an environment that can be strongly innovated by this *Industry 4.0* evolution, and for this reason the term *Logistics 4.0* has been coined. This term is used to refer to the combination of using logistics with the innovations and applications added by Cyber Physical Systems (CPS), that are physical and engineered systems whose operations can be monitored, coordinated, controlled and integrated by a computing and communication process. Essential element in the Logistics 4.0 environment is the use of real-time and inline data to achieve more efficiency and effectiveness in a logistics process, based indeed on IoT technologies.

The most significant innovative implementations that can be applied in the shipment and transportation environment and can be linked to the *Delivery Process Improvement* project will be analyzed in the following paragraphs (Figure 4.21).

4.4.1 Transportation Management Systems – TMS

This system is part of supply chain management centered on transportation logistics. Typically, it enables interactions between an Order Management System (OMS) and Distribution Center (DC), but in the operational framework of dealer and carmaker it might be rerouted and integrated with the Dealer Management System (DMS, previously mentioned), LINK software and compound management or FCA's SCM HQ directly. TMS helps companies to control and manage freight costs, and it handles electronic communication with customers, trade partners and carriers. It is based basically on Big Data and IoT technology, thanks to powerful calculators/servers and intelligent sensors.

Furthermore, TMS is important for a company to be able to use GPS technology to accurately locate its own vehicles, monitor freight movement, negotiate with carriers, consolidate shipments and interact with Intelligent Transportation Systems (ITS), that interoperates in different fields like transportation management, control, infrastructure, operations and policies. The offers in cloud services and computing are increasing, and so TMS cloud based is becoming the standard, reducing drastically the number of on premise installs on the future [18].

The potential of this system enables company to redefine their strategy, thanks to a better end-to-end supply chain visibility.

4.4.2 Tracking Mobile App

Nowadays customers are used to track their orders (e.g. Amazon order) easily on an app installed on their smartphone, which would give them detail about where their parcel is and how much remaining time is required to complete the delivery. Automotive carmakers are already moving on this path, with Audi and Opel being the first movers (Figure 4.20).

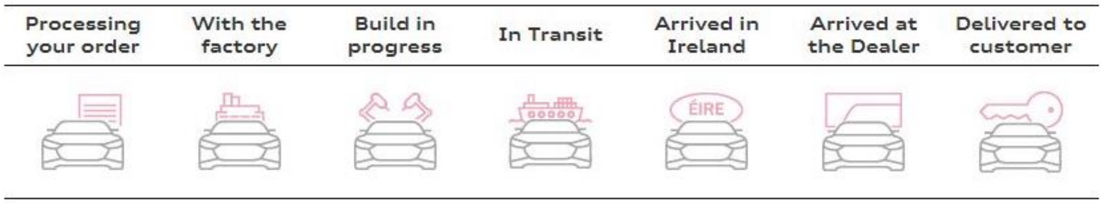


Figure 4.20 Screenshot of Audi tracking app (Source: Audi)

They offer an app that indeed satisfy the request of their customers, informing them on the status of their vehicle, if it is still in the production process or distribution phase, and making them able to purchase additional services, like accessories or particular warranties, while the car has still not arrived. FCA should consider the development of a mobile app once the solutions proposed are in place and consolidated, to move closer to the request of their customers. The implementation of this app requires a strong reliability on data, in order to avoid giving wrong information to the customer that is waiting for his/her vehicle.

4.4.3 Blockchain

This technology is very early in its adoption cycle, and it is typically known for cryptocurrency applications. But it has an immense potential to be disruptive and to revolutionize the supply chain environment.

Blockchain is a distributed database that holds records of digital data or events in a way that makes them tamper-resistant. While many users may access, inspect, or add to the data, they can’t change or delete it. The original information stays put, leaving a permanent and public information trail, or chain, of transactions [19]. Blocks store information about transactions (e.g. date, time, amount of money), participants and codes to distinguish one block from the other.

It allows to track securely and transparently all types of transactions, opening great possibilities in the supply chain world. Every time a product changes hands (and in this case the shipped vehicle), the transaction could be documented, creating a permanent history of this good, from manufacture to sale. This could dramatically reduce time delays, added costs, and human error that plague transactions today [20]. In particular, Blockchain could generate improvement in recording the quantity and transfer of assets as they move through the supply chain, tracking receipts and other documents, sharing information between manufacturer and customer (dealer) about production process, delivery and maintenance.

The advantages that the use of this technology can bring are various, and they regard enhanced transparency and visibility revealing clearly checkpoints and location of goods, greater scalability through the possibility of access by any number of participants, better security with a shared and indelible ledger with codified rules.

Some companies, and their related supply chains, are already using this technology and within a small period of time will surely expand to a huge amount of companies worldwide.

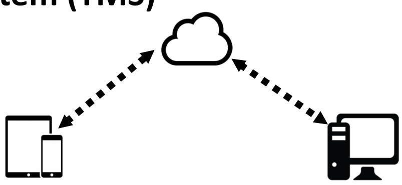
Transportation Management System (TMS) 	- Better end-to-end supply chain visibility - Integration between manufacturers, carriers and dealers
Mobile Tracking App 	- Customer involved in information exchange processes - Possibility of purchasing additional services
Blockchain 	- Secure and transparent transactions - Visibility improvement - Efficiency increase

Figure 4.21 Innovative digital technologies: key aspects (Adapted from: Tjahjono et al., 2017)

Chapter 5 – Conclusions

In the following paragraphs there will be an assessment of the expected benefits for the company that the previously proposed solutions might generate, analyzing where improvements have the most impact.

Then, the limitations of this work will be addressed, in terms of complexity of the information to be processed, approximation of used data, and a high-level of details for the analysis.

Finally, there will be an indication of future steps that the company might follow, regarding new analysis to conduct or the evaluation of disruptive technologies implementation.

5.1 Expected benefits for FCA

The first aspect that is expected to be covered by the implementation of the proposed solutions (see Chapter 4, Paragraph 4.3) is a reduction in complaints volume. Indeed, a stronger information exchange and a clearer communication between the company and the dealer are expected to induce a decrease of complaints by the customer, that should be more involved. In particular, the target of complaints reduction is 65% for Promise category, 50% for Delivery FCA and 25% for Delivery Dealer, in a two year window of time, to be aligned to other carmakers' best practices. For sure the bigger impact has to be on the Promise category, since is the major source of criticalities, and all of the proposed solutions are headed in the direction of improving customer expectation.

Delivery reliability perception, calculated as the ratio between complaint vehicles and total received surveys, is another element that is expected to improve, moving from 96% circa to 98%, based on the target set on competitors results, again to be aligned with other Original Equipment Manufacturers (OEMs).

These improvements combined with the availability of the new processes will also enable savings in customer care expenditures, regarding warnings received and surveys distribution, with a consequent long elaboration of data that will be transmitted to interested divisions.

Moreover, the forecast for the benefits include an increase in sales, with these new additional purchases guided by fidelity programs and promotions, sponsoring the new achieved reliability. In addition, the satisfaction for the brand could increase with a stronger perceived reliability, and then a customer is more likely to come back to FCA when he/she needs to purchase a new vehicle.

The overall investment will cover mostly ICT costs in the areas of Vehicle Distribution, Order Management, Dealer Management and Business Intelligence. Keeping in mind the target set by competitors the Process&Methods division calculated that the additional sales, with a forecast of more than 600 vehicles purchased in two years, combined with lower customer care costs should make the Payback be reached in 13 months, and the overall Net Present Value (NPV) will be almost 5 times bigger than the initial investment.

5.2 Limitations of the work

During the writing of this work and the previous project activities few restrictions have been met. First of all, the complexity of the information that had to be handled, because getting to know the processes for the delivery of the vehicle and the relationship between dealers and FCA was no easy task and it required some time. The blocks (mainly financial and quality) and invoices processes have not been mentioned, but having a perspective from this point of view could be interesting, and could open new topics for the analysis.

Another element of limitation is the approximation of the data that has been used. Indeed, the production times employed for the analysis belongs to vehicle with standard configuration. Vehicles with optional parts typically require more time to be scheduled and then manufactured, and since most of those included in the list of complaints did not present a standard configuration but had at least one optional, FCA took charge of more responsibility than it was actually needed. In fact, considering this statement, the Promise category should be even larger, because the ranges OCF – CCF considered for the analysis should have been compared to standard times that included these details. It must be noted that checking all the optional parts for each vehicle, understanding how much more time was required for the production, and combining all this sort of information was not the priority, since the main focus was to get a global overview of the problem.

The main limitation of this work is indeed the high-level of detail of this analysis, that does not allow to understand where problems in the micro-perspective reside. Instead, its priority is just to have a general overview of the resulted macro-area to focus on. Since the results show that the communication that dealers have with customers is critical, a deeper analysis on which dealer causes the most complaints might be useful.

5.3 Next steps for FCA

As previously mentioned, the analysis conducted had the goal to assess which where the issues of the complaint vehicles, to understand whose responsibility was, and which were the main general problems. But it could be interesting in the future to focus on those aspects (later introduced) that have not been prioritized, examining them in depth, and so many other analyses might be conducted.

The starting point for every future analysis needs to be the allocation of the appropriate production lead times to each vehicle. It might be a tough task, due to a high level of customization offered by the company for each vehicle, that leads to a large number of combination of optional parts, but it is needed to have much more detailed and reliable results.

The first study that can be made is actually a completion of what has been done previously, and it regards the complete investigation, based on the allocation of appropriate lead times, of the three categories (Promise, Delivery FCA, Delivery Dealer) to see how and if the sizes change. Theoretically the Promise category should enlarge, because the previously used data were preventive concerning the setting of standard lead times. Then, it would be interesting to understand how Delivery FCA category impacts on the overall situation, and to see if this problem is consistent.

Then, for what concerns production issues, a further study might be conducted. Keeping in mind the attribution of the proper lead times, it will be possible to cluster vehicles for model and consequently production plant (since all cars for one model are manufactured in the same plant) and check the entity of the issue and which of those is more critical, to then evaluate the appropriate solutions.

Once all of the proposed solutions are operative and consolidated, it will certainly be useful to conduct the same analysis, on a new sample of complaint vehicles, to check if customer expectation is finally set in properly, and so the situation has changed in the right way, or to see if the problem is more structural than previously thought, and much more effort is required. In case the enrollment of the new processes and methods of communication will not have the desired results, FCA definitely needs to evaluate the implementation of new disruptive technologies in this field (for example Blockchain, that is totally new for traditional companies, but with strong potential to change the market), with a strong but definitive investment, that would maybe fix the problem for certain and would allow a substantial technological progress to reduce the gap with other competitive automotive manufacturers.

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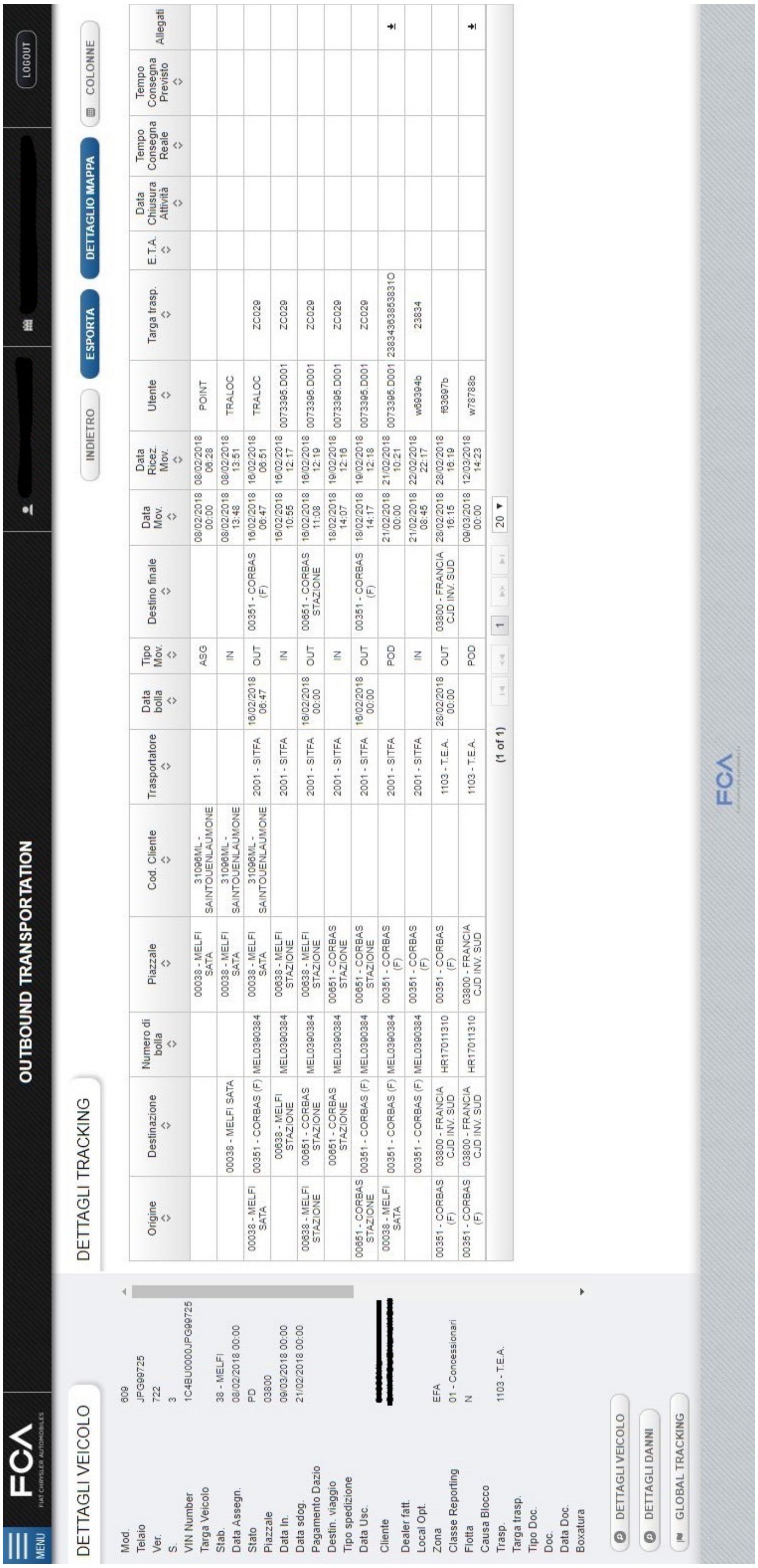
Attachments



Origine	Destinazione	Numero di bolla	Piazzale	Cod. Cliente	Trasportatore	Data bolla	Tipo Mov.	Destino finale	Data Mov.	Data Ricez. Mov.	Utente	Targa trasp.	E.T.A.	Data Chiusura Attività	Tempo Consegna Reale	Tempo Consegna Previsto	Allegati
			00038 - MELFI SATA	31096ML - SAINTOUENLAUMONE			ASG		08/02/2018 00:00	08/02/2018 06:28	POINT						
	00038 - MELFI SATA		00038 - MELFI SATA	31096ML - SAINTOUENLAUMONE			IN		08/02/2018 13:48	08/02/2018 13:51	TRALOC						
00038 - MELFI SATA	00351 - CORBAS (F)	MEL0390384	00038 - MELFI SATA	31096ML - SAINTOUENLAUMONE	2001 - SITFA	16/02/2018 06:47	OUT	00351 - CORBAS (F)	16/02/2018 06:47	16/02/2018 06:51	TRALOC	ZC029					
	00638 - MELFI STAZIONE	MEL0390384	00638 - MELFI STAZIONE		2001 - SITFA		IN		16/02/2018 10:55	16/02/2018 12:17	0073395.D001	ZC029					
00638 - MELFI STAZIONE	00651 - CORBAS STAZIONE	MEL0390384	00638 - MELFI STAZIONE		2001 - SITFA	16/02/2018 00:00	OUT	00651 - CORBAS STAZIONE	16/02/2018 11:08	16/02/2018 12:19	0073395.D001	ZC029					
	00651 - CORBAS STAZIONE	MEL0390384	00651 - CORBAS STAZIONE		2001 - SITFA		IN		18/02/2018 14:07	19/02/2018 12:16	0073395.D001	ZC029					
00651 - CORBAS STAZIONE	00351 - CORBAS (F)	MEL0390384	00651 - CORBAS STAZIONE		2001 - SITFA	16/02/2018 00:00	OUT	00351 - CORBAS (F)	18/02/2018 14:17	19/02/2018 12:18	0073395.D001	ZC029					
00038 - MELFI SATA	00351 - CORBAS (F)	MEL0390384	00351 - CORBAS (F)		2001 - SITFA		POD		21/02/2018 00:00	21/02/2018 10:21	0073395.D001	238343638538310					⭳
	00351 - CORBAS (F)	MEL0390384	00351 - CORBAS (F)		2001 - SITFA		IN		21/02/2018 08:45	22/02/2018 22:17	w69394b	23834					
00351 - CORBAS (F)	03800 - FRANCIA CJD INV. SUD	HR17011310	00351 - CORBAS (F)		1103 - T.E.A.	28/02/2018 00:00	OUT	03800 - FRANCIA CJD INV. SUD	28/02/2018 16:15	28/02/2018 16:19	f63697b						
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(1 of 1) 1 20

Attachment 4.1 Vehicle Tracking on OBT (Source: FCA)

DECEMBER 2018	Delivery time (Calendar Days) for a new order			
MODEL	DELIVERY TIME (dd)	AVAILABLE IN	PRODUCTION NOTES	AVAILABLE STOCK (Consult FOCUS)
ALFA ROMEO				
GIULIETTA 				
GIULIA 				
STELVIO 				
JEEP				
RENEGADE 				
COMPASS 				
WRANGLER 				
CHEROKEE 				
GRAND CHEROKEE 				

ILLUSTRATIVE

Attachment 4.2 ATP - Snapshot of new format (Source: FCA)

Websites

1. https://cscmp.org/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx?hkey=60879588-f65f-4ab5-8c4b-6878815ef921
2. https://beergame.opexanalytics.com/
3. https://www.ukessays.com/essays/management/dell-supply-chain-study-2688.php
4. http://www.patagonia.com/us/footprint
5. https://www.sustainabilityconsortium.org/wp-content/themes/enfold-child/assets/pdf/2016-impact-report.pdf
6. http://www8.hp.com/us/en/hp-information/global-citizenship/society/supplychain.html
7. https://www.gs1.org
8. https://www.abr.com/
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17. https://blog.smartsense.co/amazon-customer-expectations-supply-chain
18. https://logisticsviewpoints.com/author/chriscunnane/
19. https://www.investopedia.com/terms/b/blockchain.asp
20. https://www.supplychain247.com/article/why_blockchain_is_a_game_changer_for_the_supply_chain

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